Reregistration Eligibility Document for Triallate
Environmental Fate and Effects Chapter

Table of Contents

I. USE CHARACTERIZATION

Triallate is a thiocarbamate pre-emergence selective herbicide that is used to control wild oats, black grass, and annual meadow grass in barley, spring and winter wheat, triticale, peas, lentils, and summer fallow land. Triallate inhibits the synthesis of lipids and prohibits shoot growth of emerging seedlings. Depending on the crop that is treated, the herbicide is applied either before or after planting. According to the label, triallate can be applied as a surface broadcast (no-till) or incorporated in the soil. One of the marketed formulations (BUCKLE), which is a mixture of triallate and trifluralin, must only be applied by ground methods.

A. Summary of Supported Product Types, Formulations, And Use Scenarios

The six triallate herbicide products are manufactured as emulsifiable concentrates and granular formulations ranging in strength from 45-50% active ingredient in the EC formulations and 10 to 15 % active ingredient in the granular formulations. Granular triallate can be applied by aerial or ground methods where as the emulsifiable concentrate can only be applied by ground methods. Timing of applications depends on the crop to which it is applied. Label instructions include soil incorporated or soil broadcast applications at preplant/preemergence, or at plant. Label instructions specifically limit the number of applications that may be made to one application per season. It is commonly applied during early season to control weeds prior to their emergence.

B. Summary of Extent of Major Uses Nationwide

Most of the national usage of triallate is concentrated in the north central and northwestern regions of the country and encompasses up to 3 million acres of potential use. The labels for triallate, Granular FAR-GO Herbicide (EPA Reg. No. 524-292) and FAR-GO Herbicide (EPA Reg. No. 524-145), restrict triallate use to Oregon, Washington, Idaho, Montana, North Dakota, South Dakota, Minnesota, Colorado, Kansas, Nebraska, Nevada, Utah, and Wyoming. The major exposure areas for wildlife and water resources are concentrated in the wheat production areas of Oregon, Washington, Idaho, Montana, North Dakota, South Dakota, Minnesota, Colorado, Kansas, Nebraska, Nevada, Utah, and Wyoming. This corresponds with reported usage data and also U.S. Geological Survey National Water Quality Assessment (NAWQA) data which places the highest numbers and frequencies of triallate detections in surface water in the Red River North Basin, Central Columbia Plateau, Upper Snake River, and Williamete Basin areas. Also of note are some detections in the South Platte River Basin, San Joaquin and Tulane Basin of California, the Georgia-Florida Coastal Plain, and White River areas.

C. Summary of Supported Agricultural Crop Use Scenarios

Agricultural crop use scenarios that are supported for the present products are shown in Table 1. These scenarios are employed in ascertaining maximum expected environmental concentrations in water, soil, and vegetative surfaces for purposes of determining potential environmental exposure and risk to wildlife and aquatic organisms. The EPA product numbers are listed under the letter designations. Table 1 will be referred in later calculations of exposure and risk quotients.

Table 1. Summary of Use Scenarios

Scenario #-Formulation	Application Site	Max.Rate/Acre (lbs ai /ac)	Method	Timing
A-EC 524-145	spring or durum wheat	1.0	Ground spray incorporated	Preplant/At plant/after harvest
B-EC 524-145 2749-196*	barley*, lentils, field peas, succulent peas triticale and wheat*	1.25	Ground spray incorporated	Preplant/At plant/after harvest
C-EC 524-145	winter barley, wheat	1.5	Ground spray incorporated	Preplant/At plant/Fall Post harvest
E-G 524-292	barley, wheat	1.0 incorporated	Ground or Aerial Application	Preplant/ At plant/ fall postharvest
F-G 524-192	lentils, field peas, succulent peas triticale, barley,wheat	1.25 to 1.5 incorporated	Ground or Aerial	Preplant/At plant/ Fall post harvest
G-G 524-192	wheat and barley	1.5 (delayed) no incorporation	Ground or aerial	Fall Preplant
H-G 524-375	barley, durum and winter wheat, peas	1.5 triallate 0.45 trifluralin	Ground spray incorporated	spring or fall preplant
Non Food Crop Uses				
524-145 EC	Summer fallow land prior to spring plant	1.25	Ground spray	fall

* EC= Emulsifiable Concentrate G=Granular formulation

II. EXPOSURE CHARACTERIZATION

A. Chemical Profile

Common Name: Triallate
Chemical Name: S-(2,3,3-trichloro-2-propenyl)bis(1-methylethyl) carbamothioate
Class: thiocarbamate
Physical/Chemical properties:
Molecular formula: $C_{10}H_{16}Cl_3NOS$
Molecular weight : 304.66
Physical state : amber, oily liquid
Melting point : 29-30 ^{0}C
Vapor Pressure : 1.2 x10^{-4} torr
Water solubility : 4 mg/L @ 25 ^{0}C
Henry's constant : 1.2 x10^{-5} atm m^3/mol
CAS Number : 2303-17-5
Log K_{ow} : 4.55

B. Environmental Fate Assessment

The interpretation of the fate data for triallate is mainly based on the phase IV review (D158005, 1991) plus the recently submitted (December of 1998) supplemental fate data (MRID #s 44715501, 44715502, and 44715601). Because of the late submission of these supplemental studies, they were not utilized in selecting the input parameters for Tier II modeling. However, the data from these studies did not alter the fate assessment. The original submitted studies were accepted as fulfilling the data requirements, although many appear to be marginal by current standards. Although it was not specifically recognized at the time, triallate's volatility may have contributed to the difficulties encountered in earlier studies. EFED recommends that the registrant upgrade the previously submitted fate data (MRID 00144567) in accordance with the current guidelines.

Triallate is stable to chemical degradation processes including hydrolysis, aqueous photolysis, and photolysis on soil. The presence of environmental photosensitizers could contribute to triallate photodegradation in natural waters. The major mode of triallate degradation is aerobic soil metabolism, which occurs with significant mineralization ($t_{1/2}$ = 18 -20 days; MRID 00144567, 44611302). In a recently submitted study (MRID 44715601) triallate degraded aerobically with EFED calculated half lives of 37 days in clay loam at 20^{o}C, 57 and 60 days in sandy loam 1 and 2 respectively at 20^{o}C, 58 days in silty clay loam at 20^{o}C, and 98 days in sandy loam 1 at 10^{o}C. The rate of metabolism of triallate

in sandy loam soil was influenced by the temperature of the test system. Triallate metabolizes much more slowly under anaerobic conditions; 21% of the applied radio activity was recovered as parent triallate after 30 days aerobic and 60 days anaerobic incubation.

Open literature data indicate that triallate volatilization is a route of dissipation under actual use conditions. In a USGS review, triallate volatilization accounted for 15% of applied triallate for incorporated triallate and 74% of applied triallate for unincorporated triallate (Majewski and Capel, 1995). In another study (Smith et al., 1997), 21 % of applied triallate volatilized over a 24-day period after application of granular triallate.

Triallate is not expected to be mobile as indicated in the batch equilibrium data. The adsorption coefficients (K_{ads}) values ranged from 5.3 ml/g in Lintonia sandy loam to 35 ml/g in Drummer silty clay loam. Calculated K_{oc} values for triallate ranged from 1305 ml/g for Lintonia sandy loam to 2730 ml/g in Ray silt loam. Soil column leaching studies appear to confirm triallate's lack of mobility in soil. In an aged column leaching study, 7% of the applied radioactivity was found in the leachate. In a supplemental study comparing the leaching behavior of encapsulated and unencapsulated formulations (MRID 44611302), the concentration of radioactivity in the leachate (In Hodge sandy loam soil) was 4.7 % and 17.5 % of the applied C^{14}-activity for the encapsulated and the unencapsulated triallate, respectively. The leached material was mainly the metabolite 2,3,3-trichloroprop-2-ene sulfonic acid (TCPSA). Triallate volatilized with a flux of 3.6 x 10^{-3} Fg/cm^2/hr from sand trated at a rate of 1.5 lb. a.i./A. Under these conditions, half of the applied triallate would dissipate as vapor in 30 days. Virtually all of the volatilized material was parent. Because of triallate volatility under typical use conditions, particularly with the EC formulations, the label instructions indicate that triallate must be incorporated into the soil as soon as possible on the day of application.

Field dissipation studies with a granular formulation suggest that triallate dissipated with half-lives of 20-190 days in six U.S. locations (ID 60 days, SD 20 days, MT 30 days, ND 50 days, KS 85 days, and WA 190days). In five of the six locations, the half-life was 85 days or less. Factors contributing to the rate of dissipation include volatilization, soil binding, and how favorable conditions are for microbial growth.

Triallate accumulated in fish with BCF's of 700x in edible fish tissues, 2700x in viscera, and 1600x in whole fish. Depuration was >90% within 14 days after ending exposure.

The environmental fate data for the metabolite TCPSA is incomplete. This metabolite of concern is included in the Health Effects Division's tolerance expression. The submitted fate data for TCPSA were derived from structural activity relationships and from a limited number of preliminary laboratory studies. These data are deemed as supplemental for the purpose of risk assessment. Confirmatory data are needed to substantiate the supplemental data. The data indicate that the metabolite TCPSA is more mobile than the parent triallate (K_{oc}=35 ml/g) and is moderately persistent in soil ($t_{1/2}$ = 66 days).

1. Degradation

Hydrolysis studies (161-1) (Satisfied)
(MRID 00144567)

Triallate, maintained at 25 EC, was stable at pH 4, 6, 7, and 8, with 85-90% recovered as parent at pH 4. The fulfilling study is considered marginal.

Photodegradation in water (161-2) (Satisfied)
(MRID 00144567, 41541301)

Triallate is considered to be photostable in unsensitized water (MRID 00144567) . In a second study (MRID 41541301), sterile phosphate buffer (20 mM) at pH 7.0 was fortified with triallate at a concentration of 4 ppm. The test solution was subjected to a 12-hour light exposure, 12-hour dark cycle using a xenon arc lamp as a simulated sunlight source. No degradation was observed in the aqueous solution through Day 23; however, the concentration of triallate in both the light-exposed and dark control test vessels had dropped to 10% or less of the initial concentration. Therefore, the experiment was terminated. All extracts of the test system showed no evidence of triallate degradation. It was noted that the volatility of triallate may have been the reason behind the difficulty in performing a standard study on aqueous photolysis. Triallate is considered to be photostable in unsensitized water for at least 28 days. Submitted data suggest that sensitizers can greatly accelerate the photodegradation of triallate. Under conditions where photosesitizers are present, a half-life of # 24 hours is expected. A New guideline aqueous photolysis study is recommended to confirm the previously submitted data (MRID 00144567, 41541301).

Photodegradation on soil (161-3) (Satisfied)
(MRID 00144567, 41892301)

Triallate was stable on silt loam soil which was irradiated for the equivalent of 30 days. After 30 days of exposure, 90% of the applied radioactivity was recovered as parent, <1% lost as volatile material, and a small amount recovered as TCPSA (MRID 00144567). A second study (MRID 41892301) was also deemed acceptable to fulfill guideline 161-3. The study showed that after 30 days of natural sunlight exposure, triallate accounted for 88% and 79% of the applied radioactivity in the light exposed and dark controls, respectively. The major degradation products accounted for 5.8% of the Day 30 irradiated and 3.6% of the Day 30 control samples and were not identified. The trapped organic volatiles did not exceed 0.8% of the applied radioactivity for any sample. Non-extractable radioactivity was 3.2 and 1.9% of the applied for the light exposed and dark control samples, respectively. Triallate does not readily photodegrade on soil and is stable well beyond the experimental period of 30 days.

2. Metabolism

Aerobic soil metabolism (162-1) (Satisfied)
(MRID 00144567, 92187028, 44611302, 44715601)

Triallate degraded with a half-life of 18 days on Ray silt loam; CO_2 and volatiles accounted for approximately 40% of the applied radioactivity by 30 days. The organic volatiles were not identified. In the soil, 32% remained as parent and 17% was bound material by 30 days (MRID 00144567).

Radiolabeled triallate, at 2 lbs ai/A, had a half-life of 18 to 20 days for encapsulated and unencapsulated formulations (MRID 44611302) respectively. Volatilization was a major route for dissipation for triallate; after one month, the maximum triallate volatilized ranged from 35 % and 39 %. Major degradation products were identified as CO_2 and TCPSA. The maximum concentration of TCPSA was 3.4 % of the applied radioactivity. The total amount of volatiles at the end of the study was approximately 53 % and 60 % of the applied C^{14}-activity. Analysis of trapped volatiles confirmed the presence of parent triallate only.

In a recently submitted study (MRID 44715601) triallate degraded aerobically with EFED calculated half lives of 37 days in clay loam at 20°C, 57 and 60 days in sandy loam 1 and 2 at 20°C, 58 days in silty clay loam at 20°C, and 98 days in sandy loam 1 at 10°C. The rate of metabolism of triallate in sandy loam soil was influenced by the temperature of the test system. At 10°C triallate metabolized twice as slow as at 20°C. Up to 7 minor degradates were detected in the soil extracts, one of which was TCPSA (up to 4%). Six degradates were not identified. None exceeded 10% of the applied radioactivity.

Under high air flow rates, triallate volatilization can be a major route of dissipation. In this study (MRID 44715601) air flow rates were modified to 10-15 ml/min to establish reliable aerobic soil metabolism half-lives. Under these conditions up to 44% of triallate escaped the tested soil and was trapped in the polyurethane plugs. It was shown that mineralization to CO_2 [44% (clay loam at 20°C) to 17% (sandy loam 1 at 10°C) of applied radioactivity after 120 days incubation] is another route of triallate dissipation.

Open literature data suggest that common soil amendments (e.g., fertilizers) may affect the persistence of triallate. Goos and Ahrens, 1992 showed that ammonium thiosulfate (ATS, 12-0-0-26S), a common liquid fertilizer, increased the effectiveness of soil-applied triallate by reducing the microbial degradation rates in soil.

Anaerobic soil metabolism (162-2) (Satisfied)

(MRID 00144567, 92187054, 44611302)

Triallate degraded to 21% of the applied material after 30 days of aerobic followed by 60 days of anaerobic incubation. During the anaerobic phase, the only change observed was a slow loss of

parent triallate which was not accounted for by an increase of radioactivity elsewhere.

Radiolabeled triallate (formulated as encapsulate and unencapsulated), at 2 lbs ai/A, degraded to form TCPSA and CO2 in an anaerobic Ray silt loam (MRID 44611302). Encapsulated and unencapsulated triallate behaved similarly in anaerobic metabolism. Degradation half-lives were not reported.

Aerobic Aquatic metabolism (162-4) (Not satisfied)
(MRID 44715501, 44715502)

Triallate dissipated with half life of 14 days in river water containing naturally suspended solids at 20ºC, 4 days at 26ºC; 14 days in sterile deionized water at 20ºC, 5 days at 26ºC; 25 days in river water with naturally suspended solids and Dupo soil at 20ºC, 7 days at 26ºC; 20 days in river water with naturally suspended solids and sandy river bottom sediment at 20ºC, 8 days at 26ºC; and 15 days in river water with naturally suspended solids and clay bottom sediment at 20ºC, 4 days at 26ºC. TCPSA and other more polar, unidentified, triallate degradates (less than 4%) were reported to be detected in river water and sediment.

Triallate residence half life was greater after addition of sediment/soil into the river water due to triallate adsorption into the clay type sediment. Increase of temperatures from 20ºC to 26ºC speed up the trillate dissipation from water and water/sediment systems due to greater losses of triallate through volatility.

Volatility is the major route of dissipation in the river water, adsorption to the sediment is another mode of dissipation (clay type sediments); minor routes of dissipation are degradation to TCPSA and other more polar compounds and mineralization to CO_2.

3. Mobility

Leaching and adsorption/desorption studies (163-1) (Satisfied)
(MRID 00144567, 44611302)

Triallate was shown to be realitively immobile in several different soils. The following adsorption coefficients were reported: Ray silt loam, K_{ads} = 19; Drummer silty clay loam, K_{ads} = 35; Spinks sandy

loam, K_{ads} = 24; Lintonia sandy loam, K_{ads} = 5.3. Desorption coefficients and K_{oc} values have not been reported. K_{oc} values were calculated as follows: Ray silt loam, K_{oc}= 2730 ml/g; Drummer silty clay loam, K_{oc} = 1775 ml/g; Spinks sandy loam, K_{oc} = 1724 ml/g; Lintonia sandy loam, K_{oc} = 1305 ml/g. Soil column leaching and TLC studies, not discussed in the original review, appear to confirm triallate's lack of mobility in soil. In an aged column leaching study, 7% of the applied radioactivity was found in the leachate. The leached material was believed to be the metabolite (TCPSA).

In a supplemental study comparing the leaching behavior of encapsulated and unencapsulated formulations (MRID 44611302), Radiolabeled triallate applied at 1.8 lbs ai/A, was predominately detected in the 4-6 cm depth in soil columns a Ray silt loam and 12 cm depth in a Hodges sandy loam. when eluted with 0.5 inches of water for 45 days. TCPSA was the only radiolabeled residue found in the leachate for both soils. In Ray silt loam soil, the concentration of radioactivity in the leachate was 5.2 % and 4.8 % of the applied C^{14}-activity for the encapsulated and the unencapsulated formulations, respectively. In Hodge sandy loam soil, the concentration of radioactivity in the leachate was 4.7 % and 17.5 % of the applied C^{14}-activity for the encapsulated and the unencapsulated triallate, respectively.

Laboratory Volatility from Soil (163-2) (Satisfied)
(MRID 42651101)

The study was designed to test a worst case scenario for triallate dissipation by volatility. A low organic matter sand was used to minimize triallate soil binding and maximize volatility. Triallate volatilized with an average flux of 3.6 x 10^{-3} Fg/cm^2-hr from sand treated at a rate of 1.5 lb. a.i./A. Based on the average flux of volatilization, triallate would have a volatization half-life of approximately 97 days. It should be noted that an inaccurate volatilization half-life of 30 days was reported in the data evaluation record (Review of MRID 42651101, Conerly, 9/3/93).

Open literature (Smith et al., 1997) indicate that 21 % of applied triallate volatilized over a 24-day period after application of granular triallate.

Field Volatility (163-3)

Open literature data indicate that triallate volatilization is a route of dissipation under actual use conditions. In a USGS review, triallate volatilization accounted for 15% of applied triallate for incorporated triallate and 74% of applied triallate for unincorporated triallate (Majewski and Capel, 1995).

4. Dissipation

Terrestrial field dissipation studies (164-1) (Satisfied)
(MRID 00145426)

Triallate (10G formulation) dissipated with half-lives of 20-190 days in six U.S. locations (ID 60 days, SD 20 days, MT 30 days, ND 50 days, KS 85 days, and WA 190days). In five of the six locations, the half-life was 85 days or less. Factors contributing to the rate of dissipation in a given site were never fully identified, but may include: the extent to which volatilization is favored, the degree of soil binding, and how favorable conditions were for microbial growth. These studies provide information about a variety of soils. Additional information has been requested about climatological conditions and watering regimes in this study in the hope of identifying factors which contribute to triallate persistence.

5. Accumulation

Laboratory studies of pesticide accumulation in fish (165-4) (Satisfied)
(MRID 41497601, 43021201)

Available fish bioaccumulation data suggest that triallate concentration in fish will generally follow concentration trends in water. Triallate accumulated with BCF's of 700x in edible fish tissues, 2700x in viscera, and 1600x in whole fish. The residues consisted largely of parent triallate, although the degradate hydroxy-triallate reached a maximum of 24% of the applied radioactivity in the viscera. Depuration was >90% within 14 days after ending exposure.

C. Water Resource Assessment

1. Summary

Direct drinking-water data for triallate are not readily available. There is no lifetime health advisory (HA) or Maximum Contaminant Level established for triallate residues (triallate + TCPSA) by the Office of Water. Triallate residues are not included in the Unregulated Contaminant Monitoring List. Therefore, public drinking water supply systems are not required to analyze for triallate residues. Consequently, EFED relied on simulation models and other surface-and ground-water monitoring data for this exposure assessment.

Since triallate use on spring and winter wheat is expected to yield the highest source loading in surface and ground waters, these two crop scenarios were used to predict triallate residue concentrations in ground and surface waters. The degradate TCPSA is included in the water assessment because it is in the Health Effects Division (HED) triallate tolerance expression.

A major uncertainity in the surface and ground water modeling for triallate is related to the fate and transport properties of TCPSA. Additional uncertainties are associated with our inability to model drift of aerially applied granule formulations of triallate.

Tier I GENEEC modeling predicts that the maximum triallate residue (triallate + TCPSA) concentration in surface water is not likely to exceed 15.72 µg/L for peak (acute) concentration and 10.37 µg/L for 56-day average (chronic) concentration (Table 2). Tier I SCI-GROW predicts the maximum triallate residue concentration in shallow ground water is not likely to exceed 0.21 µg/L. Tier I model estimated triallate residue concentrations for both surface and ground water did not exceed the acute (non-cancer) and chronic (non-cancer) DWLOC . However, the 56-day average (chronic) triallate residue concentration in surface water exceeded the cancer DWLOC for cancer (0.42 µg/L).

Tier II surface water modeling was conducted using PRZM 3.1 and EXAMS 2.97.5. for a North Dakota use site. Tier II PRZM-EXAMS modeling predicts that the maximum triallate residue concentrations in surface water are not likely to exceed 7.67 µg/L for peak (acute) concentration, 4.12 µg/L for 90-day average (non-cancer chronic) concentration, and 1.74 µg/L for mean annual (cancer chronic) concentrations. Maximum surface water triallate residue concentrations were associated with spring application of triallate with no soil incorporation. A summary of Tier I and Tier II modeling for triallate residues is presented in table 2.

Table 2. Tier I and Tier II Estimated Concentrations for Triallate Residues* (µg triallate equivalents/L)

Maximum Concentration	**Surface Water**		**Ground Water**
	Tier1 Estimated Concentration	Tier II Estimated Concentration	
Acute	15.72 µg/L	7.67 µg/L	0.21 µg/L
Chronic	10.37 µg/L	1.74 µg/L	

*Total concentration of triallate and TCPSA.

Non-targeted surface water monitoring data from the USGS National Water Quality Assessment (NAWQA) program indicate that chronic concentrations of triallate in filtered surface waters from high use triallate areas are substantially lower than PRZM-EXAMS predictions. The maximum time-weighted annual mean concentration of triallate (parent only) in surface water is 0.094 µg/L. Surface water data from Canadian monitoring studies on unfiltered surface waters suggest similar low concentrations. There are no surface water monitoring data for TCPSA to assess runoff potential from actual triallate use, It is inappropriate to estimate the TCPSA concentration from monitoring data because triallate and TCPSA have very different physiochemical and environmental fate properties.

Tier I modeling for ground water indicates that the maximum triallate residue concentrations are not likely exceed 0.21 µg/L. Additionally, there have been no detections of triallate in ground water monitoring data from NAWQA and STORET. Triallate is not reported as analyte in the EPA Pesticides in Ground Water Database (1992). Environmental fate data for triallate suggest that it is not expected to move into groundwater because of moderately high sorption affinity to soil (low mobility) and low to moderate persistence. In contrast, TCPSA has fate properties of pesticides (low Koc and moderate persistence) found in groundwater. There are, however, no ground water monitoring data for TCPSA to assess its leaching potential under actual use conditions.

2. Surface Water Assessment

a. Tier I Modeling (GENEEC)

Tier 1 modeling results indicate that triallate has the potential to move into surface waters. This estimate is based on the maximum application rate of 1.5 lb. ai /acre with one application per season. The input parameters that were used in the GENEEC modeling are listed in Table 3. The estimated environmental concentrations (EEC's) for the acute (peak) and chronic (56-day) concentrations of triallate in surface water, for the different formulations are presented in table 4.
Since the GENEEC 56-day average concentration of triallate and TCPSA are likely to exceed the HED cancer endpoint of 0.42 µg/L, Tier II surface water modeling (PRZM-EXAMS) was performed to refine the exposure assessment.

Table 3. GENEEC Environmental Fate Input Parameters for Triallate

DATA	VALUE	SOURCE
Maximum application Rate	1.5 lb. ai/ac	Label (EPA Reg. No. 524-292, 524-145, and 524-124-AA).
Maximum Number of Applications	1	Label (EPA Reg. No. 524-292, 524-145, and 524-124-AA).
Soil Organic Carbon Partitioning Coefficient (Koc)	1305 *	MRID 00144567
Aerobic Soil Metabolism half-life	54 days**	MRID 00144567, 92187028
Aerobic Aquatic Metabolism half-life	N/A	N/A
Photolysis half-life	Stable	MRID 00144567, 41541301
Hydrolysis half-life	Stable	MRID 00144567
Solubility	4.0 ppm	EFED One-Liner

* Smallest Koc value

** Half-life is an estimate of the upper 90th Percentile half-life for triallate. Since a single aerobic soil metabolism half-life was reported for triallate, the single value was multiplied by three to approximate the upper 90th percentile half-life. This approximation is expected to account for the uncertainty in the variability of half-life.

Table 4. GENEEC EECs (µg/L) for triallate

Formulation	Incorporation Depth (inches)*	Application method	GENEEC Peak EEC (µg/L)	GENEEC 56-Day EEC (µg/L)
(Emulsifiable concentrate)	1	Ground Spray	15.75	10.37
(Emulsifiable concentrate)	2	Ground Spray	8.27	5.43
(Emulsifiable concentrate)	3	Ground Spray	5.77	3.79
(Emulsifiable concentrate)	4	Ground Spray	4.52	2.97
Granular	1	Surface Broadcast	15.12	9.96
Granular	2	Surface Broadcast	7.56	4.98
Granular	3	Surface Broadcast	5.04	3.32
Granular	4	Surface Broadcast	3.78	2.49
Granular	No incorporation	Surface Broadcast	15.12	9.96

*Different depths of incorporation were modeled to evaluate the effect on the EEC's.

b. Tier II Modeling PRZM-EXAMS

PRZM-EXAMS modeling uses a single site that represents a high-end exposure scenario for the use of a pesticide on a particular crop or non-crop use site. The meteorology and agricultural practice are simulated at the site over multiple years (in this case, 36) such that the probability of an EEC occurring at that site can be estimated. EECs were calculated for the active ingredient, triallate, using the label information.

The use of simulation models to estimate possible drinking-water exposure introduces several degrees of uncertainty to a human health or ecological risk assessment. The greatest of these may be the conservative assumptions of the modeling that are intended to ensure the maximum protection for human health. The scenario simulated by both GENEEC and PRZM-EXAMS is a single 10-hectare field draining to a 1-hectare pond with no outlet. This represents a conservative assumption, since this scenario does not accurately reflect the dynamics in a watershed large enough to support a drinking water facility.

Additional assumptions ensure that the resulting Tier II EEC s are sufficiently conservative to protect human health and the environment:

< Sites simulated in Tier II modeling are chosen by best professional judgement to be among the most vulnerable for each crop to which the pesticide is applied.

< The 10-hectare field is assumed to be completely treated with the pesticide;

< Each individual application of the pesticide is assumed to occur over the 10 hectares within one day; and

< The application rates and timing for each crop are the maximum allowed on the product label.

These conservative assumptions are intentionally chosen, in part, to account for other sources of uncertainty associated with the use of simulation models in risk assessment. The first of these is the quality of the input data used in the simulations, which is detailed to some extent above. In addition, the precipitation data used are limited to a maximum of 36 years, with no irrigation simulated in any year.

Finally, the models themselves are a source of uncertainty in the assessments. While the models are some of the best environmental fate estimation tools available, they are limited in their ability to represent some processes. Several of the algorithms (volume of runoff water, eroded sediment mass) are well validated and well understood, but no adequate validation has yet been made of PRZM 3.1 for the amount of pesticide transported in runoff events. Other limitations of these models include their inability to handle spatial variability within the simulated 10-hectare field, a lack of crop-growth algorithms, and a simplistic soil-water transport algorithm (the "tipping bucket" method).

Therefore, given these limitations, this Tier II EEC should be considered a reasonable upper bound estimate of the concentration that could be found in drinking water, and not a prediction of concentrations that would commonly be detected. Risk assessment using Tier II values can be used as refined screens to demonstrate that the risk to human health or the environment is below a level of concern. When Tier II EEC values are above levels of concern, additional data or proactive mitigation measures may be necessary, depending on the magnitude of the LOC exceedence.

c. Modeling Scenario

Tier II modeling was conducted using PRZM 3.1 and EXAMS 2.97.5. The runoff scenario represents pesticide runoff from a Fargo silt loam (fine, montmorillonitic, frigid Vertic Haplaquoll) for spring and winter wheat (Appendix A). Based on soil taxonomy, the Fargo soil has a seasonally high water table (*e.g.*, Aquic moisture regime). Additionally, the Fargo soil has high shrink-swell clays (*e.g.*, montmorillonite), which may cause vertical macropores from soil drying. Vertical macropores may

promote leaching in the soil profile. These soil hydrologic processes are not considered in the PRZM/EXAMS modeling.

Environmental fate parameters for TCPSA were derived from registrant submitted data including structural-activity relationships, preliminary laboratory data, and estimation of fate characteristics from unreviewed data. Confirmatory data are needed to substantiate the supplemental data. The maximum formation efficiency of TCPSA was assumed to be 5.2% of applied triallate as indicated in a rotational crop study (MRID 42499701). It should be noted that the TCPSA conversion efficiency does not account for the cumulative formation potential of TCPSA; supplemental soil column leaching studies indicate that TCPSA in leachate samples accounted for 17.5% of applied radioactivity (MRID 44611302).

In addition to uncertainties with TCPSA data, the modeling was conducted using interim guidance for model parameter selection; single value aerobic soil metabolism half-lives were multiplied by 3 to approximate an upper 90th percentile of the mean half-life value. Since there are no aerobic aquatic metabolism half-lives available for triallate and TCPSA, the 90th percentile aerobic soil metabolism half-lives were multiplied by 2 to calculate the aerobic aquatic rate constant (KBACW) used in exams chemical input file. There are contradictory data on the persistence of triallate in photodegradation in water studies; photodegradation of triallate appears to be dependent on the presence of sensitizers. For purposes of the aquatic exposure and drinking water assessments, triallate was assumed to photodegrade rapidly ($t_{1/2}$=24 hours) in aquatic environments because natural waters are expected to contain photosensitizers.

Model input parameters for triallate and TCPSA are shown in Tables 5 and 6. Meteorological data from 1948 to 1983 were taken from records for the USDA Major Land Resource Area MLRA F-56 (MET FILE F-56) to simulate weather conditions in Cass County, North Dakota.

Table 5. PRZM/EXAMS INPUT PARAMETERS FOR TRIALLATE			
MODEL PARAMETER	DATA SOURCE	DATA QUALITY	VALUE
Application Rates *	Label EPA Reg# 524-292-AA	Acceptable	1.4 kg/ha-Spring Wheat 1.7 kg/ha-Winter Wheat
Aerobic Soil Metabolism Rate Constant	00144567	Acceptable	0.0128 $days^{-1}$
Organic Matter Partitioning Coefficient	00144567	Acceptable	1883 ml/g
Molecular Weight	One-Liner	Acceptable	304.7 g/mole
Solubility	One-Liner	Acceptable	4.0 µg/ml
Vapor Pressure	One-Liner	Acceptable	1.2×10^{-4} torr
Henry's Constant	One-Liner	Acceptable	1.2×10^{-5} atm M^3/mol
Photodegradation in Water	00144567	Supplemental	2.8×10^{-2} $hours^{-1}$
Aerobic Aquatic Metabolism Rate Constant	NA	Estimated	2.67×10^{-4} $hours^{-1}$
Anaerobic Aquatic Metabolism Rate Constant	NA	Estimated	4.44×10^{-5} $hours^{-1}$

* Triallate application was modeled assuming a single application with a 2 inch incorporation.

Table 6. PRZM/EXAMS INPUT PARAMETERS FOR TCPSA			
MODEL PARAMETER	DATA SOURCE	DATA QUALITY	TCPSA
Application Rates[1]	NA	Estimated	0.073 kg/ha-Spring Wheat 0.088 kg/ha-Winter Wheat
Aerobic Soil Metabolism Rate Constant	Oppenhuizen 1983	Supplemental	0.0035 $days^{-1}$
Organic Matter Partitioning Coefficient	ESD-9607 Screen	Supplemental	35 ml/g
Molecular Weight		Acceptable	226 g/mole
Solubility	Moran, 1998	Estimated	47100 µg/ml
Vapor Pressure	NA	NA	0[2]
Henry's Constant	NA	NA	0[2]
Photodegradation in Water	NA	NA	Stable[2]
Aerobic Aquatic Metabolism Rate Constant	NA	Estimated	7.29×10^{-5} $hours^{-1}$
Anaerobic Aquatic Metabolism Rate Constant	NA	NA	Stable[2]

1- TCPSA application was modeled assuming a 5% conversion efficiency for TCPSA.
2- Data were not available (NA)

Tier II modeling indicates that maximum cumulative triallate residues concentrations from fall application on winter wheat are not likely to exceed 5.178 µg triallate equivalents/L for the 1 in 10 year annual peak (acute) and 0.396 µg triallate equivalents/L for annual mean concentration (Table 7). The maximum cumulative triallate residues concentrations from spring applications on spring wheat are not likely to exceed 7.671 µg triallate equivalents/L for the 1 in 10 annual peak (acute) and 1.739 µg triallate equivalents/L for the annual mean concentration (Table 8).

The registrant (Monsanto) conducted PRZM-EXAMS modeling for triallate and TCPSA. The modeling was conducted using an exaggerated application rate of 2.0 lbs. ai/A; the maximum label application rate for triallate is 1.5 lbs. ai/A. Additionally, the registrant used a TCPSA formation rate of 0.002 $days^{-1}$ in the PRZM simulation. There is no reference on the source for this formation rate. Based on the registrant's PRZM-EXAMS modeling, the maximum annual mean cumulative triallate residue concentration is 0.777 µg/L triallate equivalent for a spring application of non incorporated triallate.

Table 7. Triallate Residue Concentration (µg. triallate equivalents/L) in Surface Water for Winter Wheat in North Dakota

Concentration	Triallate		TCPSA		Cumulative Triallate Residues[2]	
	2" incorporation	No incorporation	2" incorporation	No incorporation	2" incorporation	No incorporation
Peak[1]	2.009	4.350	0.379	0.828	2.388	5.178
90 Day Average[1]	0.566	1.233	0.364	0.790	0.93	2.023
Mean Annual	0.087	0.191	0.093	0.205	0.18	0.396

1-1 in 10 year concentration
2-Summation of triallate and TCPSA

Table 8. Triallate Residue Concentration (µg. triallate equivalents/L) in Surface Water for Spring Wheat in North Dakota

Concentration	Triallate		TCPSA		Cumulative Triallate Residues[2]	
	2" incorporation	No incorporation	2" incorporation	No incorporation	2" incorporation	No incorporation
Peak[1]	2.464	5.501	0.997	2.170	3.461	7.671
90 Day Average[1]	0.927	2.070	0.942	2.049	1.869	4.119
Mean Annual	0.262	0.588	0.528	1.151	0.79	1.739

1-1 in 10 year concentration
2-Summation of triallate and TCPSA

2. Groundwater Assessment

SCI-GROW (version 1.0 dated May 22, 1997), the model used for estimating the ground-water EEC, is a screening level model developed by Dr. Michael Barrett of EPA/OPP to estimate the maximum ground-water concentration from the application of a pesticide to crops. SCI-GROW is based on the fate properties of the pesticide, the application rate, and the existing data from small-scale ground water monitoring studies. The model assumes that the pesticide is applied at its maximum rate in areas where the ground-water is particularly vulnerable to contamination. Usually, a considerable portion of any use

area will have ground-water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimates. As such, the estimated maximum concentration derived using SCI-GROW should be considered a high-end to bounding estimate of acute exposure. If the risk associated with this estimate is exceeded, either at the acute or chronic endpoints, refinement of the exposure estimate will be necessary to better characterize actual exposures.

The SCI-GROW model (ver. 2.0) predicts that groundwater concentrations of cumulative triallate residue concentrations in shallow ground water are not likely to exceed 0.21 µg /L (Table 9). Input parameters for the SCI-GROW are reported in Table 1.

Table 9. SCI-GROW Triallate Residue Concentrations (µg. triallate equivalents/L) in Groundwater

Crop	Triallate	TCPSA	Cumulative Triallate Residues*
Winter Wheat	0.03	0.18	0.21
Spring Wheat	0.02	0.15	0.17

* Total concentration of triallate and TCPSA.

3. Monitoring Data

a. Groundwater Monitoring Data

Triallate is not reported as an analyte in the EPA Pesticide in Ground Water Database. There were no reported ground water detections of triallate in the STORET database. Recent data from non-targeted USGS NAWQA program (Kolpin et al, 1998), indicate that there have been five detections of triallate in shallow ground water. The detected concentration ranged between 0.001- 0.002 Fg/L. However, it should be noted that none of these detections were in aquifers that are considered to be major suppliers of drinking water. Additionally, the reported NAWQA detections for parent triallate are approximately an order of magnitude lower than the SCI-GROW model prediction (0.02 µg/L). Environmental fate data for triallate suggest that triallate is not expected to move into groundwater because of moderately high sorption affinity to soil (low mobility) and low to moderate persistence. In contrast, TCPSA has fate properties of pesticides (low K_{OC} and moderate persistence) found in groundwater. There are, however, no ground water monitoring data for TCPSA to assess leaching potential under actual use conditions.

b. Surface Water Monitoring Data

Surface water monitoring data for triallate were taken from the USGS NAWQA database, Environment Canada River Monitoring Program, STORET, and from open literature data. However, there are no monitoring data to assess the potential of TCPSA to be transported into surface waters.

USGS National Water Quality Assessment Monitoring Data

The NAWQA monitoring data were evaluated to assess the geographic distribution and magnitude of triallate in ambient surface waters.

The USGS NAWQA database indicates that 96% of the surface water samples had non-detectable concentrations of triallate (Table 10). To avoid misrepresenting the data, a statistical analysis of the national NAWQA database was evaluated using the assumption that non-detects were equal to ½ the limit of detection (LOD). Since the analytical method in the NAWQA data has a high analytical recovery of triallate with low variation (94%, SD=4%), there is high confidence in the triallate monitoring data as reported in the NAWQA database.

Table 10. National Descriptive Statistics for NAWQA Surface Water Data on Triallate

Statistic	Detections	Detection Limit Modified Data*
Count	209	5193
---------- µg/L ----------		
Median	0.0100	0.0005
Mode	0.005	0.0005
Mean	0.0356	0.0019
Standard Deviation	0.0822	0.0179
Minimum	0.002	0.0005
Maximum	0.6500	0.6500

* Non detections were assumed to be equal to ½ the limit of detection (LOD)

An analysis of the monitoring data was conducted to evaluate the regional distribution of triallate detections (Table 11). The NAWQA study units with triallate detections as a percentage of samples analyzed are: the Red River of the North Basin (49.5%), Central Columbia Plateau (36%.3), Upper Snake River (8.6%), Willamette Basin (2.7%), South Platte Basin (1.9%), San Joaquin-Tulane Basin (1.4%), Georgia-Florida Coastal Plain (0.3%), and White River (0.2%).

Based on the USGS triallate use map, triallate is used in all the NAWQA study units with triallate detections except the White River and Georgia-Florida Coastal Plain study units (http://water.wr.usgs.gov/pnsp/use92 /trial.html). The labels for triallate, Granular FAR-GO Herbicide (EPA Reg. No. 524-292) and FAR-GO Herbicide (EPA Reg. No. 524-145), restrict triallate use to Oregon, Washington, Idaho, Montana, North Dakota, South Dakota, Minnesota, Colorado, Kansas, Nebraska, Nevada, Utah, and Wyoming. The NAWQA study units with the highest frequency of triallate detections and highest concentrations of triallate, Red River of the North Basin and Central Columbia Plateau, correspond to high triallate use areas (> 11 lbs. ai per square mile).

Table 11. Descriptive Statistics for Detection Modified Data (µg/L)

STUDY UNIT	DESCRIPTIVE STATISTICS				
	Count	Median	Mean	Max	Min
Red River Basin	216	0.002	0.011	0.28	0.0005
Central Columbia Plateau	215	0.0005	0.240	0.65	0.0005
Upper Snake River	150	0.0005	0.00080	0.006	0.0005
Willamette Basin	184	0.005	0.005	0.008	0.002
South Platte Basin	157	0.0005	0.0010	0.036	0.0005
San Joaquin_Tulane Basin	437	0.0005	0.0005	0.006	0.0005
Georgia-Florida Coastal Plain	383	0.0005	0.0005	0.004	0.0005
White River	544	0.0005	0.0005	0.003	0.0005

Since the Northern Basin of the Red River and Central Plateau of the Columbia River NAWQA study units had the highest surface water concentrations of triallate, highest detection frequency of triallate, and the highest areal use of triallate, additional regional analysis was conducted for each sampling station in these two study units (Appendix B). It should be noted that triallate was detected in several locations (Georgia, Florida, and Indiana) which are outside the label restricted use area for triallate. The exact reason(s) for these detections is difficult to assess because there is no apparent linkage between triallate usage and detection. One plausible explanation is that triallate transport via volatilization and long-range transport may have contributed to triallate deposition in the non-triallate use areas.

In the Northern Red River Basin study unit, the maximum concentration of triallate was 0.28 µg/L at sampling station 5085900. The maximum time-weighted mean (TWM) and arithmetic mean for detection modified data were 0.0776 µg/L and 0.027 µg/L, respectively. The highest triallate

concentrations were detected at the bottom of the watershed (Red River of the North Emerson-Site 4), which serves as an integrator site of the Red River Basin. Triallate concentrations in the Wild River at Twin Valley and Red River of the North Emerson reached a

maximum of 0.07 and 0.28 µg/L, respectively, in April and then fell to the LOQ (0.001 µg/L) for the rest of the year. Since the maximum triallate concentrations occurred before the spring runoff event and then rapidly declined, the runoff of triallate may be related to movement of fall applied triallate in snow melt. Similar observations have been observed in monitoring data from Canada. .
In the Central Plateau of the Columbia River NAWQA study unit, the maximum concentration of triallate was 0.65 µg/L at sampling station 12464770. The maximum time-weighted mean (TWM) and arithmetic mean for detection modified data were 0.0938 µg/L and 0.099 µg/L, respectively. Triallate detections were exclusively associated with dryland agriculture in the Palouse River and Upper Crab Creek watersheds where use is high. In contrast, there were no triallate detections in the Crab Creek Lateral and EL68D Wasteway watersheds, where irrigation is prevalent but use is low. The triallate detection frequency in the different watersheds is closely related to the extent of triallate use in the watersheds. The amount of triallate used in the Palouse and Upper Crab watersheds was 240,000 lbs./year and 3,000 lbs./year, respectively. In contrast, the amount of triallate used in the Crab Creek Lateral and EL68D Wasteway was 330 lbs./year and 160 lbs./year, respectively.

Quantitative Assessment of NAWQA Monitoring Data

The NAWQA monitoring data for the North Basin of the Red River and Central Columbia Plateau were evaluated for each NAWQA sampling station. The monitoring data was evaluated for the maximum annual peak, time weighted annual mean for non-detection modified data, time weighted mean without non-detections, and the arithmetic annual mean. The minimum criterion for calculating time weighted means for each sampling station was at least 4 samples in a single year. For purposes of the assessment of non-detection-modified monitoring, non-detectable data were modified to be equal to ½ the detection limit.

The equation used for calculating the time weighted annual mean is as follows:

$$\frac{[((T_{0+1}-T_o) + ((T_{0+2}-T_{0+1})/2))*C_{T0+1})] + 3(((T_{I+1}-T_{I-1})/2)*C_i) + [((T_{end}-T_{end-1})+((T_{end-1}-T_{end-2})/2)*C_{Tend-1})]}{\text{-------}\\ 365}$$

where: C_i=Concentration of pesticide at sampling time (T_i)

T= Julian time of sample with concentration C_i
T_0=Julian time at start of year=0
T_{end}=Julian time at end of year=365

Pesticide Data for Prairie Surface Waters from Environment Canada (November 6, 1997)

The Environment Canada Surface Water Monitoring Program provided triallate concentrations for 25 rivers in the Canadian Prairie region. The highest concentration of triallate was 102.0 µg/L in a single sample (#876274, 10/1/87) for the Qu'Appelle River. However, further analysis of this detection indicates an error; the correct concentration is 0.0026 µg/L (FAX, Bing Chu to Dr. Andrew Klien, Monsanto, 2/20/98). All other samples from 1986 to 1989 were below the limit of quantification (LOQ) of 0.01 µg/L.

Grover, R., D.T. Waite, A. J. Cessna, W. Nicholaichuk, D. G. Irvin, L. A. Kerr and K. Best. 1997. Magnitude and Persistence of Herbicide Residues in Farm Dugouts and Ponds in the Canadian Prairies. Envir. Tox. Chem. 16:638-643.

These data represent triallate concentrations in farm ponds/ dugouts in 4 soil regions in Saskatchewan from the fall of 1987 to the spring of 1989. Based on 1987 to 1988 use data, triallate was used only in two of these regions (Balgonie and Regina). The surface area of the farm ponds ranged from 130 to 2,204 m^2 and received runoff waters from surrounding drainage areas of 7 to 99 ha. The average depth of the farm ponds was not reported. Runoff volumes ranged from 0 to 2,083 m^3 for the farm pond watersheds. Duplicate water samples were taken before seeding (spring), after herbicide application (summer),and after harvesting (fall). Water samples were taken at the center of the reservoir at a depth of 0.5 m. Unfiltered water samples were extracted with n-hexane, concentrated, and then analyzed by GC. The minimum quantification limit was 0.05 µg/L. Percent recoveries ranged from 73% to 112% for concentrations ranging from 0.1 to 1 µg/L.

Triallate was detected in farm ponds in all soil regions. The detection frequency of triallate was highest (63% of the samples) in the Regina soil region. The triallate detection frequency in the other soil regions ranged from 38% to 48%. The maximum detection frequency of triallate was in Fall water samples. The maximum concentration of triallate was 0.87 µg/L in the spring, 0.05 µg/L in the summer, 0.19µg/L in the fall. The authors contend the high detection frequency of triallate in the spring water samples suggests that fall applied triallate is moving in snowmelt waters. Additionally, the low triallate concentrations in summer and fall water samples suggest that triallate is not likely to persist in water.

Muir, D.C.G. and N. Grift. 1987. Herbicide Levels in Rivers Draining Two Prairie Agricultural Watersheds (1984). J. Environ. Sci. Health. B22(3):259-284.

This is a surface water monitoring study in the Turtle River and Ochre River watersheds in western Manitoba. These watersheds were selected to compare the impact of agriculture on water quality. The Turtle River watershed (648 km^2) is predominately impacted by agriculture. In contrast, the Ochre River watershed (302 km^2) is dominated by forest. Herbicide use data in the watersheds were derived from 1983 and 1984 insurance surveys. Triallate was used exclusively in the Turtle River watershed; 102 kg of triallate was used in 1984 on insured land for wheat production. The author estimated that 306 kg of triallate was used in the watershed based on the percent of wheat acres in the watershed. Water samples were taken at surface of the river at specified sampling locations. EFED notes the sampling protocol was not clearly described in the paper. Water samples were taken on March 14, April 13, April 27 and weekly thereafter to October 10. Unfiltered water samples were extracted with dichloromethane and then analyzed by GC. The detection limits for the GC method ranged from 0.002 to 0.250 µg/L. The percent recovery of triallate from spiked water samples was 79.4% for the 0.025 µg/L and 101.7% for 0.250 µg/L.

The water concentration of triallate never exceeded 0.025 µg/L. In the Turtle Creek watershed, the maximum triallate concentration was 0.0104 µg/L in May. In the Ochre River watershed, the maximum triallate concentration was 0.0024 µg/L. Triallate water concentrations did not correlate with river flow. The author suggested that triallate deposition in surface waters may be due to dust or volatilization because 1984 was a relatively dry year with few runoff events.

Klein, A. 1998. Drinking Water Assessment for Triallate: Estimates for Surface Water Based on the "Surface Water Mobility Index".

The registrant submitted data predicted triallate water concentrations from the Surface Water Model Index (SWMI). The chronic triallate water concentration is estimated to range from 0.0005 to 0.001 µg/L. The SWMI has been reviewed by EFED. A memorandum on the surface water regression model is attached.

III. TERRESTRIAL EXPOSURE ASSESSMENT

A. Terrestrial Vegetation Exposure

1. Exposure Concentrations for Non-target Terrestrial Wildlife and Insects

For pesticides applied as a nongranular product (e.g., liquid, dust), the estimated environmental concentrations (EECs) on food items following product application are compared to LC50 values to

assess risk. The predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb. ai/A are tabulated below.

Table 12. Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb. ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue [(1)]	EEC (ppm) Predicted Mean Residue *
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants, and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

* Predicted maximum and mean residues are for a 1 lb. ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al*. (1994).

Table 13. Maximum Terrestrial EEC Table - Triallate Crop Scenarios

Scenario #- Formulation	Application Site Pre or at Plant to soils	Max. Rate/Acre (lbs. ai)	Max EEC Range after incorporation.**
A-EC* 524-145	spring or durum wheat	1.0	7-135 ppm
B-EC 524-145 2749-196*	barley*, lentils, field peas, succulent peas triticale and wheat*	1.25	9-168 ppm
C-EC 524-145	winter barley, wheat	1.5	10.5-202
E-G* 524-292	barley, wheat	1.0 incorporated	1.56 mg ai/ft2 at 2 " depth
F-G 524-192	lentils, field peas, succulent peas triticale, barley, wheat	1.25 to 1.5 incorporated	2.34 mg ai/ft2 at 2 " depth
G-G 524-192	wheat and barley	1.5 (delayed) no incorporation	15 mg ai/ft2 at surface
H-G 524-375	barley, durum and winter wheat, peas	1.5 triallate 0.45 trifluralin	3.1 mg combined ai/ ft 2 (10%/3% ratio)

Table 13. Maximum Terrestrial EEC Table - Triallate Crop Scenarios			
Non Food Crop Uses			
524-145	Summer fallow land prior to spring plant	1.25	9-168 ppm

* EC= Emulsifiable Concentrate G=Granular formulation

** Vegetation numbers not used due to incorporation. Maximum number is for small insects

2. Exposure Levels From Granular Application

Granular exposure from 1.5 lbs. ai/A incorporated is based on conversion of application rates to mg ai/ sq. ft. An exposure component of 15% is assumed with 2 inch incorporation. Thus, the equation used is as follows.

$$\text{mg ai/ft.}^2 = \frac{\text{applied rate lb. ai/A} \times 453{,}590 \text{ mg/lb.} \times 15\%}{43{,}560 \text{ sq. ft / acre}} = 2.34 \text{ mg ai/ft}^2$$

Without incorporation the potential exposure could approximate 15.6 mg ai/ft2

B. Aquatic Organism Exposure Estimates

Table 14. Maximum Aquatic GENEEC derived EEC Table - Triallate Crop Scenarios			
Scenario #-Formulation	**Application Site**	**Max. Rate/Acre (lbs. ai)**	**Max EEC 0- 56 Day Range in µg/L**
A-EC* 524-145	spring or durum wheat	1.0 2 "incorporated	5.51 to 3.62
B-EC 524-145 2749-196	barley, lentils, field peas, succulent peas triticale and wheat	1.25 2 " incorporated before 24 hours	6.89 to 4.53
C-EC 524-145	winter barley, wheat	1.5 2" incorporated	8.27 to 5.43
E-G** 524-292	barley, wheat	1.0 2 " incorporated	5.04 to 3.32
F-G 524-192	lentils, field peas, succulent peas triticale, barley, wheat	1.25 to 1.5 2 " incorporated before 48 hours	7.56 to 4.98
G-G 524-192	wheat and barley	1.5 (delayed) no incorporation	15.12 to 9.96
H-G*** 524-375	barley, durum and winter wheat, peas	1.5 triallate 0.45 trifluralin	7.56 to 4.98 triallate 2.0 to 0.12 trifluralin
Non Food Crop Uses			
I-EC 524-145	Summer fallow land prior to spring plant	1.25	6.89 to 4.53

* EC= Emulsifiable Concentrate **G=Granular formulation *** H-G = BUCKLE dual active granular-EECs obtained from trifluralin RED document.

Table 15. PRZM EXAMS Exposure Estimates for Application to Wheat Only					
Scenario/Formulation	**Crop**	**Rate/Method**	**Peak in PPB**	**90 Day Mean**	**Annual Mean**
Granular/Cass County, N.D.	Spring Wheat	1.4 Kg/ha with 2" incorporation.	2.464	0.914	0.244
Granular/Cass County, N.D	Winter Wheat	1.5 Kg/ha with 2" incorporation	2.009	0.566	0.094
North Dakota	Spring Wheat	1.4 Kg/ha delayed or no incorporation	5.501	2.070	0.547

IV. ECOLOGICAL EFFECTS HAZARD ASSESSMENT

A. Mode of Toxicological Behavior

Triallate does not appear to accumulate in plant tissues, but instead is metabolized by them. Triallate appears to inhibit the synthesis of lipids . Generally, thiocarbamates have been shown to be rapidly adsorbed from the mammalian gastrointestinal tract into the bloodstream. In testing with rabbits a single oral dose of triallate produced residue adsorption in all tested organs within 20 minutes after adsorption into the gastrointestinal tract. Highest detections were in the liver, lungs, kidneys, and spleen. It is broken down into polar metabolites and then excreted. In rabbits, no residues were detected in these organs 7-10 days after ingestion. Following exposure for 7 weeks to triallate residues bluegill sunfish did bioaccumulate the chemical. However, after 2 weeks depuration appeared nearly complete.

B. Toxicity to Terrestrial Animals

1. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of pesticides to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland game bird). Results of avian oral acute tests with triallate are shown in Table 16.

Table 16. Avian Acute Oral Toxicity

Species	%ai	LD50(mg/Kg) (CL's)	Toxicity Category	MRID	Author/year	Classi-fication
Bobwhite quail	95	2251(1792-2828)	practically non-toxic	ACC244201	Fink, R. 1980	core *
Mallard duck	NA	No data	NA	NA	NA	NA

* Core (study satisfies guideline).

Based on the minimal data reviewed to date, triallate displays low acute oral toxicity to the one species of bird tested. The acute oral data does fulfill 71-1 testing guidelines.

Two subacute dietary studies using the TGAI are required to establish the toxicity of a pesticide to birds. The preferred test species are mallard duck and bobwhite quail. Results of subacute dietary tests with triallate are tabulated below.

Avian reproduction studies using the TGAI are usually required for pesticides when the following conditions are met: (1) birds may be subject to repeated or continuous exposure to the pesticide,

especially preceding or during the breeding season, and (2) information derived from mammalian reproduction studies indicates reproduction in terrestrial vertebrates may be adversely affected by the anticipated use of the product. The preferred test species are mallard duck and bobwhite quail. The guideline (71-4) was not originally required by the Agency in original data requests. However, the registrant has recently submitted a single study completed in 1990 (see Table 17 bellow). No effects to reproduction were observed in the 20 week exposure of bobwhite quail to technical grade triallate at concentrations ranging from 80 to 500 ppm. Reduction in male adult growth was observed at 500 ppm when compared to male control birds.

Table 17. Avian Subacute and Chronic Dietary Toxicity

Species	%ai	LC50(ppm) or LOEL	NOEL	Toxicity Category	MRID	Author/year	Classi-fication
Bobwhite quail	96	>5620 ppm	5620	practically nontoxic	40370609	Grimes, J. 1986	core
Bobwhite quail	tech	LOEL=500 (20 wk exp.)	200	growth effects males	44700701	Beavers, J.B., WLI, 1990	core*
Mallard duck	98	>5620 ppm	3160	practically nontoxic	40370609	1986	core

* Core for application rates which do not exceed EEC levels of 500 ppm

Based on the test results reviewed to date, triallate displays very low toxicity to avian species on a subacute dietary basis. The dietary studies are considered acceptable by the Agency and fulfill 71-2 guideline requirements. The reproduction study partially fulfills avian reproduction testing guideline 71-4 with triallate producing no statistically significant effects ($p<0.05$) to reproduction of bobwhite quail during a 20 week exposure of up to 500 ppm. Some effect to male weight was observed, but this weight loss was not observed in female birds. No field or pen studies with triallate have been submitted to or reviewed by the Agency.

2. Mammals, Acute and Chronic Toxicity

Wild mammal acute toxicity testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse acute toxicity values are obtained from the Agency's Health Effects Division (HED) and substitute for wild mammal testing. These toxicity values are reported below. In general , triallate demonstrates moderate acute toxicity. Prolonged ingestion may lead to reduced fetal growth, altered motor activity, and potential reduced fetal body weight.

Table 18. Mammalian Acute Oral and Chronic Dietary Toxicity					
Species	**%ai**	**Acute (LD50 or LOEC)**	**NOEL (parameter)**	**MRID**	**Category**
Rat	Tech.	LD50=1220 mg/kg LD50=3455 mg/kg (F)	NR	00109746 44660701	accepted
Rabbit	95.1	Oral intubation 12 days LOEC=15 mg/Kg/day (300 ppm)	5 mg/Kg/day (100 ppm estimated *) reduced fetal growth /skeletal formation	00248293	accepted
Rat	NR	1 Day Dietary Neurotoxicity LOEC=300mg/Kg/D	60 mg/Kg/day (1200 ppm estimated) Altered motor activity-1-14 days	42908101	accepted
Rat	NR	2 year dietary LOEC =250 ppm (12.5 mg/Kg/day)	50 ppm based on reduced survival and reduced body wt. And increased adrenal wt.	40384701	accepted
Rat	94.5	2 generation repro. LOEL=30 mg/Kg/day	7.5 mg/Kg/day (150 ppm)reduced pregnancy and shortened gestation	NR	accepted

* Food conversion factor of 0.05 as used by Health Effects Division

4. Non-target Beneficial Insect Toxicity

a. Terrestrial Insects

A honey bee acute contact study using the TGAI is required for triallate products because uses may result in honey bee exposure due to aerial application drift to blooming non-target plants. A honey bee foliar residue contact toxicity study is required using the typical end-use product when residues are expected to persist and the chemical displays high contact toxicity. Because most triallate uses are unlikely to result in significant honey bee exposure to vegetative surfaces after application, and due to its low acute toxicity from direct contact, the foliar residue contact study was not originally required. However, the registrant has provided a foliar toxicity study recently and this data is also included below.

Table 19. Non-target Pollinator Insect Acute Contact and Dietary Ingestion Toxicity						
Species	**%ai**	**LD50 (µg ai/Bee) 48 Hr LC50 ppm**	**Toxicity Category**	**MRID**	**Author/ year**	**Classification**
Honey bee	Tech	>25 µg ai/bee	nearly non-toxic	42304301	Hoxter, K.A. 1992	core
Honeybee	Tech	>1000 ppm	nearly non-toxic	44700801	1993, Hoxter K.A., Wildlife International	core

Triallate has been tested with honey bees on an acute contact basis through exposure to direct spray. Guideline 141-1 is fulfilled. The registrant has recently submitted a 1993 study on foliar toxicity of triallate . The study results indicate that foliar toxicity hazard from ingested residues is unlikely with an LC50 exceeding 1000 ppm. Aerial applications of granular triallate are unlikely to exceed 300 ppm residue levels on non-target plants. Triallate does not appear to demonstrate any significant toxicity to honeybees. Guidelines 141-1 and 141-2 are fulfilled.

5. Toxicity to Terrestrial Soil Invertebrates

The registrant has submitted an acute toxicity study with the earthworm *Eisenia fetida*, conducted at Wildlife International. The study demonstrated the acute toxicity of triallate to earthworms exposed for 14 days in 6 different concentrations of triallate in soils. The results demonstrated an LC50 level of 549 mg ai/Kg of dry soil with confidence intervals of 450-750 mg ai/Kg dry soil. The NOEL was estimated to be 162 mg ai/Kg of soil. Although this study is not yet required under FIFRA guidelines the information is deemed useful for assessing potential hazard to these types of soil invertebrates, which are crucial to healthy soils.

C. Toxicity to Aquatic Animals

1. Vertebrates

a. Acute Toxicity to Freshwater and Estuarine / Marine Fish

Two freshwater fish acute toxicity studies using the TGAI are required to establish the toxicity of a pesticide to freshwater fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Acute toxicity testing with estuarine/marine fish species using the TGAI is required for triallate because the active ingredient is expected to reach this environment due to potential use on certain crops located near estuarine environments (eg. wheat, peas). The preferred estuarine test species is sheepshead minnow.

b. Chronic Toxicity To Freshwater Fish

A freshwater fish early life-stage test and/or an estuarine fish early life stage test using the TGAI is required for pesticides when some end-use products may be expected to contribute residues which may be transported to water from the various intended use sites. In addition, the following chronic testing guideline conditions are met: triallate is intended for use such that its presence in water is likely to be recurrent, some acute values are less than 1 mg/l, and studies of other organisms indicate the reproductive physiology of fish may be affected. The preferred test species are the rainbow trout. As triallate is expected to persist in aquatic environments for over 4 days the chronic fish testing guidelines for triallate were required (Guideline 72-4). An early life stage study has been submitted by the registrant.

Results of toxicity studies which have been submitted and reviewed by the Agency are summarized below in Table 20.

Table 20. Freshwater Fish Acute / Chronic Toxicity of Triallate

Species Tested	% ai	LC50 (CLs) in PPB	NOEL	MRID	Author/year	Category
Freshwater Fish Species						
Bluegill sunfish	96.9	96 hr=1300 (100-1800)	560	lab id # AB-79-072	Thompson, C. 1979 ABC laboratories	core
Bluegill sunfish	92.7	96 hr=1330 (710-1400)	<270	ACC 241961	1974 Bionomics Inc	core
Bluegill sunfish	46.5	96 hr=2400 (1800-3200)	N.R.	ACC 245191	1981, ABC Laboratories	core for product
Rainbow trout	96.9	96 hr=1200 (960-1500)	560	ACC 245961	Thompson, C. 1979	core
Rainbow trout	tech	21 day=580	N.R.	N.R.	1989	supl.
Rainbow trout	46.5	96 hr=1500 (1000-3150)	N.R.	ACC 245191	1981, ABC Laboratories	core for product
Chronic Studies						
Rainbow trout	96.8	LOEC =78	NOEC= 38	44660901	Drottar, Kurt R., 1998, WLI	In Review

Based on the acute toxicity data reviewed for triallate to freshwater fish, triallate is classified as

moderately(LC50> 1000 µg/L) to highly (LC50 < 1000 µg/L) toxic to the tested species. Based on the results of the fish early life stage test, triallate is classified as highly toxic to fish on a chronic basis. Egg hatch success was effected at 160 ppb and all aspects of growth were effected at 78 ppb. Guidelines 72-1 and 72-4 are satisfied for freshwater fish.

A freshwater fish full life-cycle test (Guideline 72-5) using the TGAI is required for pesticides if the end-use product is expected to be transported to water from the intended use sites. In addition, the following conditions must be met: the EEC is equal to or greater than one-tenth of the NOEL in the fish early life-stage or invertebrate life-cycle test, and studies of other organisms indicate the reproductive physiology of fish may be affected. The preferred test species is fathead minnow. A satisfactory full life cycle test has not been submitted or required for triallate. However, the requirement is held in reserve due to results of early life stage testing and model predicted exposure residues.

2. Aquatic Invertebrates

a. Acute Toxicity to Freshwater Invertebrates

A freshwater aquatic invertebrate toxicity test using the TGAI is required to determine the potential impact of a pesticide to numerous species within this large group. The preferred test species is *Daphnia magna*. Results of freshwater invertebrate acute toxicity tests reviewed by the Agency are shown in Table 21 below.

Table 21. Freshwater Invertebrate Acute and Chronic Toxicity

Species Tested FW=Freshwater SW=Marine species	% ai	48 hr EC50, 96 hr LC50 in PPB	NOEC	MRID	Author	Classi-fication
Freshwater Invertebrate Species						
Water flea, *Daphnia magna* (FW)	95%	48 hr=91 (79-103)	43	41895601	McNamara, P.C. 1992	core
Daphnia magna (FW)	96%	48 hr=430 (380--490)	180	241961	Thompson, C. 1979	core
Chronic Toxicity - 21D LOEC in PPB						
Daphnia magna (FW)	95.5	21D LOEC=28*	13	41895601	McNamara, P.C. 1990	supl.

*Effected parameters were survival and offspring/female

Since the LC50/EC50 values are in the range of 0.09 - 0.4 ppm, triallate is classified as highly toxic to freshwater aquatic invertebrates on an acute basis. The guidelines 72-2 invertebrate acute testing with freshwater invertebrates are fulfilled by these studies.

b. ChronicToxicity to Freshwater Invertebrates

Freshwater life cycle tests using the TGAI are required for pesticides when the end-use product may be expected to be transported to water from the intended use site, and the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent regardless of toxicity, (2) aquatic acute LC50 or EC50 are less than 1 mg/l, and (3) the EEC in water is equal to or greater than 0.01 of any acute EC50 or LC50 value. In addition, testing with other organisms may indicate the reproductive physiology of invertebrates may be affected. The preferred test species are *Daphnia magna* for freshwater. Since triallate is predicted to be persistent in water, these testing requirements were required for freshwater species. Chronic toxicity of triallate is shown to be high to daphnia (see table above). Guidelines 72-4 for freshwater invertebrates are not fulfilled for triallate as growth was not measured in the daphnid study. Growth endpoints may be lower (or higher).

c. Toxicity to Estuarine Organisms

Testing requirements remain outstanding, but in reserve for estuarine fish, mollusc, and invertebrate shrimp or mysid (Guideline 72-3). Labeled uses of triallate are not expected to cause exposure to estuaries due to present geographical limitations on the labels. Chronic testing with estuarine fish or shrimp is held in reserve at this time due to geographical use restrictions on the labels.

D. Toxicity to Plants

1. Terrestrial Plant Toxicity

Terrestrial plant testing studies for triallate have been reviewed at this time and the 123-1 guideline is satisfied. Potential toxicity of triallate to non-target crops or native plants can be estimated from this data. As triallate is a herbicide effective against a wide variety of grasses and weeds, it is predicted that triallate will be highly toxic to certain non-target non-crop plants as well. The data reviewed to date is summarized in Table 22 below. With the exception of ryegrass, oat, and cucurbit related species, toxicity to terrestrial plants appears to be low at up to 1.5 lbs. ai/A.

Table 22. 21 Day EC25 Values for Ten Crop Species in lb. ai/A of Triallate			
Crop Tested	Seedling Emergence EC25 (NOEL) MRID=41871801 Chetram, R.S. 1992	Vegetative Vigor EC25 (NOEL) MRID=42471701, R.S. Chetram 1992	Category
Radish	>1.5 (1.5)	>1.5 (1.5)	core
Tomato	>1.5 (1.5)	1.4 (0.5)	core
Cabbage	0.41 (0.056)	>1.5 (0.056)	core
Corn	>1.5 (1.5)	>1.5 (1.5)	core
Onion	0.87 (0.019)	>1.5 (1.5)	core
Soybean	NR (0.50)	<1.5 (0.5)	core
Lettuce	0.23 (0.17)	>1.5 (1.5)	core
Ryegrass	0.054 (0.019)	0.11 (0.056)	core
Oat	0.020 (0.010)	0.033 (0.009)	core
Cucumber	0.18 (0.05)	0.072 (0.056)	core

2. Aquatic Plant Toxicity

Aquatic plant testing guidelines for triallate are not satisfied at this time. Triallate has been tested by the EPA laboratories with estuarine aquatic algae species. However, the registrant has not submitted the total number of required aquatic plant studies generally required for herbicides. Due to its uses near a variety of aquatic habitats, it is likely that aquatic exposure will occur to non-target aquatic plants. The following table (Table 23) summarizes the results of studies compiled by F.L. Mayer from our Agency's Gulfbreeze laboratory using 99% triallate with only 2 day exposure periods as well as a single 96 hour study conducted by ABC Laboratories using *Selenastrum capricornutum*.

Table 23. Aquatic Plant Toxicity				
Species Tested	**% ai**	**48 hr. EC50 (Cls) in PPB**	**Author, year and MRID**	**Category**
Pavlova gyrans	99%	530NR)	F.L. Mayer, 1986. 40228401	Supl.
Pavlova lutheri	99%	790NR)	F.L. Mayer, 1986. 40228401	Supl.
Isochrysis galbana	99%	390NR)	F.L. Mayer, 1986. 40228401	Supl.
Dunaliella tertiolecta	99%	1, 400(NR)	F.L. Mayer, 1986. 40228401	Supl.
Selenastrum capricornutum	NR	120 (59 - 240) NOEC =32	Forbis, Alan, 1984. 44700901	Supl.

Based on these results, triallate can be classified as highly to moderately toxic to non-target estuarine/marine algal species. The single study with *Selenastrum capricornutum* was conducted under OECD methodology where effect is based on cell mass reduction instead of measurement of effects to actual cell counts. In addition, purity of the test material was not reported. These studies do not fulfill guideline requirements according to present EPA standards as they are either not the correct species , were not conducted for 4-5 day exposure periods, or were not conducted according to accepted methodology. The complete aquatic plant testing guideline 123-2 remains unfulfilled for triallate and is required.

E. Toxicity of Degradates and Impurities

No data have been reviewed regarding the toxicity of triallate degradates or impurities to nontarget wildlife and aquatic species. Based on preliminary fate data, several triallate degradates display significant persistance and therefore may be of environmental concern. TCPSA has been mentioned for human health concerns.

V. ECOLOGICAL RISK ASSESSMENT

A. Exposure and Hazard to Nontarget Terrestrial Wildlife

The acute risk quotients for broadcast applications of nongranular products are shown in Table 24 below. They are based on estimated acute and chronic residue levels calculated in the terrestrial exposure portion of this document divided by the LC50 or chronic NOEC of the most sensitive species tested.

1. Birds

Avian acute and chronic risk quotients for single application of non-granular products (broadcast or foliar spray) are based on the most sensitive species LC50 and chronic NOEC. Triallate is not expected to exceed the LC50 level for bobwhite or mallard at maximum permitted application rate of 1.5 lbs. ai/acre, and therefore acute hazard from a single application of triallate is unlikely. This is supported even further if rapid incorporation is carried out.

The aerobic soil metabolism half-life of 98 days on sandy loam would indicate that maximum expected concentrations of triallate on soils will degrade to ½ the initial dosage within a 98 day period. This would reduce maximum predicted food source residue levels from a 1.5 lb. ai application to 101 ppm in 98 days. Estimates of potential chronic exposure were based on exposure to mean maximum exposure residues for an 98 day period on soils where bacterial degradation is a factor. No foliar dissipation

half life data have been provided. This would be preferable for estimating residues on foliar, fruit, seed or insects on which birds may feed.

Granular exposure from 1.5 lbs. ai/A incorporated is based on conversion of application rates to mg ai/ sq. ft. An exposure component of 15% was assumed with 2 inch incorporation.

The risk quotient results indicate that for a single broadcast application of non-granular products, avian acute high (0.5), restricted use (0.2), and endangered species (0.1) levels of concern are not exceeded at the highest application rates for triallate. The lowest reported LC50 concentration does not exceed maximum residues which might be expected from a 1.5 lb. ai/acre application.

Table 24. Avian Acute/Chronic Risk Quotients Small Insects *

Avian Acute LC50 > 5620 ppm (mallard) Acute LD50=2251 mg/Kg (bobwhite) NOEL=200 ppm(bobwhite)

Scenario #-Formulation	Crops	Applied Max. Rate/Acre(lbs. ai)	Acute Diet RQ	98 D Mean EEC	Chronic RQ for Growth
A-EC**	wheat	1.0 incorp.	<0.024	68 ppm	0.34
B-EC	barley, snap beans, garbanzos, lentils, peas(dried), triticale and wheat	1.25 incorp.	<0.030	85 ppm	0.42
C-EC	barley, wheat	1.5 incorp.	<0.036	101 ppm	0.5
E-G**	barley, wheat	1.0 incorp.	0.0035***		
F-G	barley, snap beans, garbanzos, lentils, peas, triticale and wheat	1.25 -1.5 incorp.	0.002		RQs not estimated for granulars
G-G	barley, wheat	1.5 delayed or no incorp.	0.013		
H-G dual active	barley, durum and winter wheat, peas	1.5 triallate 0.45 trifluralin			RQs not estimated for mixtures
Non Food Crop Use					
I-EC	Summer fallow land in fall prior to spring plant	1.25 incorp.	<0.030	85 ppm	0.42

*Small insect maximum dietary number used for EC formulation due to soil incorporation only

** EC= Emulsifiable Concentrate G=Granular formulation

***Granular RQs based on LD50/ft2 with toxicity dose corrected to 200 gram body wt (2251/5=450 mg)

Chronic risk quotients would normally be calculated based on the average residues on food items over time divided by lowest no adverse effect levels observed in avian reproduction studies. Average residues result from the pesticide degrading over the course of time from the first to last application. One chronic avian study with bobwhite quail was reviewed for triallate. The no observed effect level for bobwhite quail was estimated to be 200 ppm based on slight, but statistically significant ($p < 0.05$) reductions in male body weight at 500 ppm. A chronic hazard assumption would be based on exposure to residue levels on food items above the 200 ppm concentration from a single application of triallate degrading over time. The risk quotients for chronic risk are not exceeded for potential growth effects. In addition the degree of exposure is less likely after several weeks as residue levels are expected to decline below the NOEC level. In addition incorporation may occur shortly after application, thus reducing exposure potential to residues on soils and other food sources even further. Chronic risk estimates from exposure to granulars are not performed by the Agency at this time.

2. Mammals

Based on risk quotients, triallate does not exceed acute risk quotients for mammals(0.5) or levels which would require restricted use (0.2). However, triallate does exceed protective levels of concern for endangered small mammals(0.1). Estimating the potential for adverse effects to wild mammals is based upon EEB's draft 1995 SOP of mammalian risk assessments and residue exposure methods predicted by Hoerger and Kenaga (1972) as modified by Fletcher *et al*. (1994). The concentration of triallate in the diet that is expected to be acutely lethal to 50% of the test population (LC50) is determined by dividing the LD50 value (usually rat LD50) by the % (decimal of) body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC50 value. Risk quotients can then calculated for three separate weight classes of mammals (15, 35, and 1000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds). The acute risk quotients for broadcast applications of nongranular products are tabulated in the following table. Unfortunately, many of the mammalian chronic studies conducted for human health analysis are two year studies which are not truly comparable to a single season exposure period expected for wild mammals. In many of the chronic mammal studies less noticeable sublethal effects were noted such as cholinesterase inhibition or abnormal development of internal organs. These types of effects would, in all probability, go unnoticed during field use of triallate.

a. Acute Risk Quotients for Non-granular Products

$$RQ = \frac{\text{EEC (ppm)}}{\text{LD50 (mg/kg)/ \% Body Weight Consumed}} \quad \text{or} \quad \frac{\text{EEC}}{\text{NOEC}}$$

Table 25. High Exposure Scenarios for Dietary Consumption by Small Mammals:					
Crop/App. Method	**Rate (lbs. ai/A)**	**One Application Day 0 Max. EEC Range for Small Insects**	**Day 98 EEC Based on Soil Metabolism Half-life**	**Acute RQ Range 15 g Body Wt Consuming 95%**	**Acute RQ Range 35 g BodyWt Consuming 66%**
Fallow land EC	1.25	168	85	0.13	0.04
wheat EC	1.5	202	101	0.15	0.05

Small Mammal-15 gram Wt consuming 95% of Food Matter as Small insects
Small Mammal of 35 gm Wt consuming 66% of Food Matter as Small insects
Calculations based on rat LD50 of 1220 mg ai/Kg

b. Acute Risk Quotients for Granular Applications

Triallate is used both as an incorporated and unincorporated (delayed through winter) granular. For risk assessment purposes, the delayed incorporation is assumed as an unincorporated application for characterizing exposure to wildlife. Unincorporated granular use does exceed levels of concern for a small mammal such as a white-footed mouse. Larger mammal risk concern levels are not exceeded. Risk quotients for incorporated granular uses do not exceed any mammalian risk quotients.

Mammalian Acute Risk Quotients for Granular Products (Broadcast).

Mammalian Acute RQ (LD50/ft^2)

Calculated for a White-footed Mouse

15.6 mg ai ft2/ 1220 mg/Kg x 0.026 Kg mouse=0.49 LD50s ft2

This calculation is based on 100% exposure to unincorporated granules on winter wheat for a small mammal.

15.6 mg ai/ft2/1220 mg Kg x 0.4 Kg rat = 0.03 LD50/ft2 for a 400 gm rat

These numbers would be far lower for 2 " incorporated uses where only 15% exposure to surface granules is expected (2.34 mg ai/ft2)

3. Hazard to Non-Target Insects

Direct application contact to honeybees with triallate residues has shown low toxicity, indicating that little hazard would be expected from aerial or spray applications of triallate to exposed pollinator insects. Currently, EFED does not quantify risk to nontarget insects. Results of acceptable studies and actual field use observations are used for recommending appropriate label precautions. Acute toxicity to honeybees from foliar contact with triallate residues cannot be assessed due to lack of data.

Spray drift to aquatic habitats may produce adequate residue levels to prove hazardous to aquatic larvae of insects which later become important terrestrial members of the insect community (ie, dragonflies, mayflies, damselflies, snipeflies, caddisflies, stoneflies etc.). Mortality to these types of larvae was not characterized due to lack of toxicity data for triallate. However, triallate has shown high toxicity to other types of aquatic invertebrates (crustacea).

B. Risk to Nontarget Freshwater or Estuarine Aquatic Organisms

Based on predicted model simulation results and lack of reported fish kill incidents there does not appear to be serious acute hazard to fish from contamination of aquatic habitats adjacent to or within target application areas for triallate use sites, despite the relatively high toxicity of triallate to these groups.

However, this analyses is incomplete without further data regarding estuarine organism toxicity. Tables 26 and 27 present risk quotients for various application scenarios for agricultural uses of triallate. Risk quotients which exceed 0.5 are considered to present acute hazard to the species in question. Risk quotients which exceed 0.1 are considered to offer potential hazard to endangered species within these groups (fish, crustacea, molluscs, amphibia, etc). The tables below present risk quotients for invertebrates and fish in the same table. The first number in each scenario cell pertains to the RQ associated with the acute EC50 or chronic NOEC associated with *Daphnia magna*. The second number in the cell represents the RQ for fish based on the LC50 of the bluegill sunfish. The chronic NOEC for the fish early life stage test is based on early life stage study results with rainbow trout.

Table 26. Triallate Crop Scenarios - Aquatic Acute/Chronic RQ Table					
Scenario #-Formulation	**Crops**	**Applied Max. Rate lbs. ai/A**	**EEC in ppb Day 0,21,56****	**Acute RQ**	**Chronic RQ**
A-EC*****	wheat	1.0 incorp. 2" depth(ground)	5.5, 4.5,3.6	0.06 inv. 0.004 fish	0.35 inv 0.10 fish
B-EC	barley, snap beans, garbanzos, lentils, peas, triticale and wheat	1.25 incorp. 2" (ground)	6.9, 5.7, 4.5	0.07 inv 0.006 fish	0.44 inv 0.12 fish
C-EC	barley, wheat	1.5 incorp. 2" (ground)	8.3, 6.8, 5.4	0.010 inv 0.007 fish	0.52 inv 0.14 fish
E-G*	barley, wheat	1.0 incorp. 2"	5.0, 4.2, 3.3	0.05 inv 0.004 fish	0.32 inv 0.09 fish
F-G	barley, snap beans, garbanzos, lentils, peas, triticale and wheat	1.25 -1.5 incorp.	7.6, 6.2, 5.0	0.09 inv 0.006 fish	0.48 inv 0.13 fish
G-G	barley, wheat	1.5 delayed or no incorp.	15.1, 12.5,10.0	0.16 inv 0.012 fish	0.96 inv 0.26 fish
H-G* dual active	barley, durum and winter wheat, peas	incorporated 1.5 triallate 0.45 trifluralin	RQ's not estimated for Mixtures		
Non Food Crop Use					
I-EC	Summer fallow land in fall prior to spring plant	1.25 ground incorporated		0.07 inv 0.006 fish	0.44 inv 0.15 fish

* EC= Emulsifiable Concentrate G=Granular formulation H-G= BUCKLE dual active granular

** EEC based on 1 Hectare, 2 meter deep pond (20 million liter) with 10 hectare drainage basin and 2 inch incorporation depth

Table 27. PRZM-EXAMS Derived Aquatic RQs

Crop	Use rate (lbs. a.i./A)	Interval (days)	No. of appl.	Model Results (ppb)				
				PRZM/EXAMS EECs (Fg/L)			Acute/Chronic RQ's	
				peak	21- day	60- day	Inv.	Fish
Wheat	1.4 Kg/ha spring wheat 2" incorporation	N/A	1	2.464	1.592	1.113	0.027/0.122	0.002/0.029
	1.7 Kg/ha winter wheat 2" incorporation	N/A	1	2.009	1.201	0.718	0.022/0.092	0.002/0.019
	1.4 Kg/ha spring wheat no incorporation	N/A	1	5.501	3.579	2.486	0.060/0.275	0.005/0.065
	1.7 Kg/ha winter wheat no incorporation	N/A	1	4.350	2.604	1.561	0.048/0.200	0.004/0.041

Table 28. Terrestrial Plant Risk Quotient using Oats seedling emergence EC25 of 0.020 lbs. ai/A assuming 5 cm incorporation with EC formulation

Crop/Rate	EEC 1% Drift lbs. ai/A	RQ Drift	EEC 5%* Runoff lb. ai/A	RQ Runoff	Combined RQ
Non Target Terrestrial Plants from 1 acre					
Wheat/1.5 lbs. ai/A	0.015	0.75	0.015	0.75	1.5
Wheat/1.0 lbs. ai/A	0.010	0.5	0.010	0.5	1.0
Non-Target Semi-Aquatic Plants Surrounding 1 Acre Water Body in 10 Acre Drainage Basin					
Wheat/1.5 lbs. ai/A	0.15	7.5	0.15	7.5	15
Wheat/1.0 lbs. ai/A	0.10	5.0	0.10	5.0	10

*****EEC runoff = $\frac{\text{rate x 5\% runoff x acreage}}{\text{Incorporation in cm}}$

VI. ENDANGERED SPECIES

Endangered species LOCs are not exceeded for acute hazard to endangered fish, insects, or birds for triallate uses. Levels of concern for acute toxicity to endangered species are exceeded for small mammals consuming 95% of their body weight in small insects, but not for larger mammals or small mammals strictly feeding on seeds or fruit. Acute hazard to certain listed plant groups is possible from triallate runoff or drift. Acute hazard LOCs for endangered invertebrates are exceeded for applications with EC formulations and granular unincorporated(delayed incorporation) uses.

The Agency has developed a program (the "Endangered Species Protection Program") to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that will eliminate the adverse impacts. At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989), and is providing information to pesticide users to help them protect these species on a voluntary basis. As currently planned, the final program will call for label modifications referring to required limitations on pesticide uses, typically as depicted in county-specific bulletins or by other site-specific mechanisms as specified by state partners. A final program, which may be altered from the interim program, will be described in a future Federal Register notice. The Agency is not imposing label modifications at this time through the RED. Rather, any requirements for product use modifications will occur in the future under the Endangered Species Protection Program.

VII. INTEGRATED ECOLOGICAL RISK AND EXPOSURE CHARACTERIZATION

A. Characterization Summary

The major route of dissipation for triallate is microbial mediated degradation and volatilization. Triallate exhibits moderate persistence in terrestrial and aquatic environments. A minor degradation product (# 5.2 % of applied) of triallate is TCPSA. Supplemental data indicate that TCPSA is moderately persistent and highly mobile in soil and aquatic environments. Environmental fate and transport modeling predict that TCPSA is likely to move into ground and surface waters. Hence, the annual average concentrations of TCPSA in surface water are expected to be greater than parent triallate.

Monitoring data indicate that triallate was detected in surface water in the northern tier states of the United States (*e.g*. Minnesota to Washington) and was also detected in the Canadian Prairie Provinces. These detections in surface water are associated with the wheat and other small grain production areas. Recent data from non-targeted USGS NAWQA program (Kolpin et al, 1998), indicate that there have been five detections of triallate in shallow ground water. The detected concentration ranged between

0.001- 0.002 Fg/L. However, it should be noted that none of these detections were in aquifers that are considered to be major suppliers of drinking water. There are no ground or surface water monitoring data for the triallate degradate TCPSA. The monitoring data for parent triallate suggest that the risk of drinking water exposure is less than that predicted by simulation models.

EFED concludes that the use of triallate is not likely to pose significant risk to birds, fish, large mammals, reptiles or nontarget insects in terrestrial environments. LOCs are exceeded for endangered small mammals, however this risk is dependent on ingestion of high amounts of contaminated insects or seed in the diet. This potential risk may be reduced for incorporated uses of triallate.

Based on Tier II modeling results from wheat use, LOCs are exceeded for acute risk to endangered invertebrates (RQ > 0.05), but not for acute high risk or restricted use RQs (RQ $\geq$ 0.2) for fish or invertebrates. Triallate exceeds acute high risk, restricted use, and endangered species triggers for terrestrial and semiaquatic plants. Acute risk to aquatic plants will be determined upon receipt of aquatic plant studies as required under guideline 123-2. The toxicological and exposure data suggest that effects on aquatic invertebrates are possible from certain types of triallate exposure (see uncertainties in shallow habitats below).

An important uncertainty may increase the risk factors to aquatic organisms. The major use areas of triallate include many areas which have substantial wetland and pothole habitats. For example, 7% of the total land area of the Red River Basin is covered by wetlands. Small grain, edible bean and sugarbeet crops commonly surround numerous small prairie pothole areas (USGS Water Resources Investigations Report 96-4129). Estimated concentrations predicted by present modeling scenarios may underestimate potential residue loading to these shallow areas. Crustacea populations, such as daphnia, are sensitive to triallate (and to trifluralin that is mixed with triallate in BUCKLE). Reductions in these food sources may affect north central waterfowl populations that are highly dependent on aquatic invertebrate diets.

A second uncertainty involves drift from aerial applications of granular triallate. EFED does nt have data to quantify drift from aerial application of granulr formulations. Thus, drift to aquatic habitats has not been assumed in any Tier II modeling. Only ground applications with granular triallate were modeled with PRZM/EXAMS in this risk assessment.

Triallate residues from runoff and or ground spray drift pose hazard to certain species groups of non-target plants (mainly those related to oats, ryegrass, or cucurbits). Though difficult to precisely measure, volatilization, drift and subsequent redeposition may offer some additional potential for off target plant exposure.

B. Characterization of Water Resource Exposure Risk

1. Drinking Water

The drinking water and aquatic exposure assessment for triallate was conducted on triallate and its degradate TCPSA. TCPSA was included in the water assessment because it is listed in HED tolerance expression for triallate. Direct drinking-water data for triallate are not readily available. There is no lifetime health advisory (HA) nor a Maximum Contaminant Level established for triallate residues (triallate + TCPSA) by the Office of Water. Triallate residues are not included in the Unregulated Contaminant Monitoring List. Therefore, public drinking water supply systems are not required to analyze for triallate residues. Consequently, EFED relied on simulation models and other surface-and ground-water monitoring data for this risk assessment. Since triallate is used mainly on small grains (spring wheat and winter wheat), it is expected that triallate use on small grains is the highest source contribution of triallate loading into surface and ground waters. Therefore, winter wheat and spring wheat scenarios were used as standard scenarios for aquatic exposure and drinking water assessments. The monitoring data used in the assessment were derived from non-targeted monitoring studies in the United States and Canada.

The drinking water exposure assessment, based on monitoring and modeling data, indicate that triallate (parent only) concentrations are below the cancer DWLOC. However, with no monitoring data available for the metabolite, TCPSA, and that Tier II surface water model predicted EEC of cumulative triallate residues exceeding the cancer DWLOC, EFED cannot conclude with reasonable certainty that triallate residues concentrations will not exceed the HED DWLOC for cancer (0.42 µg/L).

a. Surface Water

Tier 1 GENEEC modeling predicts that the maximum triallate residue (triallate + TCPSA) concentration in surface water is not likely to exceed 15.72 µg/L for peak (acute) concentration 1(acute) and 10.37 µg/L for 56 day average (chronic) concentration. Because the 56-day average triallate residue concentration in surface water exceeded the cancer DWLOC (0.42 µg/L), Tier II PRZM-EXAMS modeling was conducted, to refine the Tier 1 surface water assessment.

Tier II PRZM-EXAMS modeling predicts that the maximum triallate residue (triallate + TCPSA) concentrations in surface water is not likely to exceed 7.67 µg/L for peak (acute) concentration, 4.12 µg/L for 90 day average (non-cancer chronic) concentration, and 1.74 µg/L for mean annual (cancer chronic) concentrations. Maximum surface water triallate residue concentrations were associated with spring application of triallate with no soil incorporation.

Non-targeted surface water monitoring data from the USGS National Water Quality Assessment (NAWQA) program indicate that chronic concentrations of triallate (parent only) in filtered surface

waters from high use triallate areas are substantially lower than PRZM-EXAMS predictions. The maximum time-weighted annual mean concentration of triallate (parent only) in surface water is 0.077 ppb. Surface water data from Canadian monitoring studies on unfiltered surface waters suggest similar trends. There are no surface water monitoring data for TCPSA to assess runoff potential from actual triallate use.

b. Ground Water

Tier 1 modeling for ground water indicates that the maximum triallate residue (triallate + TCPSA) concentrations are not likely exceed 0.21 ppb, which is below the DWLOCs for triallate and TCPSA. Triallate is not reported as an analyte in the EPA Pesticide in Ground Water Database. There were no reported ground water detections of triallate in the STORET database. Recent data from non-targeted USGS NAWQA program (Kolpin et al, 1998), indicate that there have been five detections of triallate in shallow ground water. The detected concentration ranged between 0.001- 0.002 Fg/L. However, it should be noted that none of these detections were in aquifers that are considered to be major suppliers of drinking water. Additionally, the reported NAWQA detections for parent triallate are approximately an order of magnitude lower than the SCI-GROW model prediction (0.02 µg/L). Environmental fate data for triallate suggest that triallate is not expected to move into groundwater because of moderately high sorption affinity to soil (low mobility) and low to moderate persistence. In contrast, TCPSA has fate properties of pesticides (low K_{OC} and moderate persistence) found in groundwater. There are, however, no ground water monitoring data for TCPSA to assess leaching potential under actual use conditions.

2. Uncertainties and Limitations in the Triallate Water Assessment

a. Modeling

The main uncertainty in ground and surface water modeling, beyond that normally associated with the models, is the lack of Subdivision N guideline environmental fate data for TCPSA. The registrant generated fate data indicate that TCPSA exhibits environmental fate properties (low Koc and moderate persistence) of pesticides capable of moving into surface and ground water. An additional uncertainty is associated with the formation and decline on rates of TCPSA. As a first approximation, EFED used the highest concentration of TCPSA (expressed as 5.2 % of parent) observed in a confined crop study MRID 42499701 as the TCPSA application rate. This application rate, therefore, did not account for the cumulative concentration (assuming no degradation) of TCPSA formed during triallate degradation. However, it should be noted that 17.5 % of the applied triallate was identified as TCPSA in soil column leaching study (MRID 44611302). Analysis of leachate by HPLC indicated that it contained only one metabolite that was identified as TCPSA. Although there are several uncertainties associated with

modeling TCPSA, the environmental fate data (low Koc and moderate persistence) for TCPSA are expected to yield an appropriate level of conservatism to the water assessment.

Other uncertainties with the modeling in the water assessment are associated with the 1.) volatility of triallate, 2.) the impact of formulation with dual active ingredients (e.g., BUCKLE) on fate and transport processes, 3.) modeling of drift from aerial application of granules. Triallate volatilization was not directly modeled in the water assessments. However, the aerobic soil metabolism half-life of triallate represents multiple dissipation pathways including microbial degradation and volatilization. Triallate volatilization, therefore, was indirectly incorporated into the water assessments through the use of aerobic soil metabolism half-lives. The lack of direct accounting of triallate volatilization is likely to lower predicted ground and surface water concentrations of triallate, especially for applications with no soil incorporation.

For purposes of the water assessments, it was assumed that formulations of dual active ingredients have limited impact on the fate and transport processes of triallate and TCPSA. Additionally, the surface water modeling of triallate did not account for the aerial drift of granular formulations of triallate (e.g., FAR-GO, AVADEX). EFED notes that drift of aerial applied granules was not addressed through the Spray Drift Task Force. However, it is anticipated that triallate drift is likely to occur through aerial application of granular triallate, especially with no buffer zones. The inclusion of a drift component in the water assessment is expected to elevate the predicted concentrations of triallate in surface water; however, the magnitude of this effect cannot be assessed at this time.

b. Monitoring

Uncertainties and limitations with ground and surface monitoring data are predominately associated with 1.) the representativeness of non-targeted monitoring studies for assessing triallate concentrations, 2.) preparation and analysis of water samples, and 3.) the lack of monitoring for the triallate degradate TCPSA. Based on an assessment of the NAWQA surface water data, triallate detections in surface water were predominately associated with high triallate use areas such as the Central Columbia Plateau and the Northern Basin of the Red River. Although there were triallate detections in other NAWQA study units, these study units were not associated with current triallate use areas as based on current geographical use restrictions on triallate labels. Hence, it is difficult to assess the source of triallate in the NAWQA study units where no triallate use is reported. Other Canadian monitoring studies were evaluated in the water assessment. However, these studies are difficult to interpret because 1.) unfiltered water samples were used in the analysis and/or 2.) triallate use data was not reported. Since triallate has a moderately high soil sorption coefficient, it is expected to bind to suspended sediments in surface waters. Triallate concentrations from unfiltered water samples, therefore, are expected to exaggerate the triallate concentrations in surface water samples. Additionally, several of the Canadian monitoring studies were not linked to pesticide use data. Although there are several issues associated

with the available monitoring data, EFED believes there are adequate monitoring data to conservatively assess the annual mean concentrations of triallate in surface water.

The ground-water monitoring data for triallate is more difficult to evaluate because triallate is not listed as an analyte in the EPA Pesticides in Ground Water Database. There were no reported ground water detections of triallate in the STORET database. Recent data from non-targeted USGS NAWQA program (Kolpin et al, 1998), indicate that there have been five detections of triallate in shallow ground water. The detected concentration ranged between 0.001- 0.002 Fg/L. However, none of these detections were in aquifers that are considered to be major suppliers of drinking water. The fate properties of triallate (volatility and soil sorption) suggest that leaching into ground water is not expected to be a major route of dissipation.

A major limitation of the monitoring data is that the degradate TCPSA was not an analyte in the monitoring studies. Since this degradate exhibits properties of pesticides (low Koc and moderate persistence) in found in surface and ground waters, it is expected to move into surface and ground waters. EFED notes that the registrant has submitted a protocol for a surface water monitoring program for TCPSA and triallate.

C. Characterization of Risk to Non-target Organisms

The following section identifies major routes of exposure expected to lead to effects on ecological resources and the highest exposure levels for drinking water sources. The use patterns of highest Agency concern are those expected to cause the highest off-target EECs of triallate (unincorporated uses of triallate and aerial applications without any label specified aquatic buffer zones).

1. Summary of Expected Paths of Potential Exposure for Wildlife

a. Ground Application to Agricultural Sites

Limited exposure to birds and mammals is expected as most ground applications to agricultural crops are incorporated into the soil and applied only once, usually in the spring or late fall. Soil invertebrates and some burrowing mammalian species such as moles may be exposed to buried residues. Avian species which probe the soil for invertebrates could also be exposed to ground incorporated triallate residues. During winter months oral exposure in drinking water via residues in prairie potholes is a potential path of avian (particularly waterfowl) and mammalian exposure.

b. Ground Application to Conservation Reserves

Application to fallow land or conservation reserve areas in fall months will offer the highest degree of exposure for avian and mammalian species as this application scenario does not require incorporation until the following spring.

c. Drift from Agricultural Uses

Triallate is generally applied as a ground application with low drift potential. The permitted aerial application of granular formulations presents a scenario not normally encountered in risk assessments and not covered by present drift estimate methods. Thus there is uncertainty as to whether drift from such applications will occur. The registrant has stated that aerial application constitutes a small proportion of total triallate application (1%). However, the method remains on several product labels.

d. Runoff in Agricultural Scenarios

Runoff of triallate residues is expected to be the major path of residue contribution to aquatic habitats as outlined in the surface water exposure section of this document. This exposure path is particularly likely with bare ground applications in the spring or fall months which may be characterized by the heaviest rains and resulting soil transport. Fall applications with 4-6 month delayed incorporation may permit subsequent runoff of triallate residue in snowmelt the following spring. Monitored triallate residues have shown some correlation with this as numbers were highest in early spring months. The bioavailability of triallate residues within the water column is not totally clear, however initial exposure following runoff may be highest in sediment surface layers.

2. Spatial Distribution of Potentially Effected Habitats and Species Groups

a. Terrestrial Wildlife Utilization of Major Triallate Usage Areas

The following summary of potential major exposure areas for triallate usage is based on EPA Quantitative Usage Analysis data. Maximum usage estimates were used to allow for potential shifts in market usage of triallate products. Species expected in various crop scenarios were drawn form Wildlife Utilization of Croplands, Gusey, William F. And Z. Maturgo, 1973. The purpose of this portion of the document is not to categorize every species type that could conceivably be exposed to triallate use sites, but instead to provide a general overview of the species types which might be present for crop and non-crop use sites and to categorize which areas of the country (where possible to predict) may be most heavily impacted by the type of use pattern.

b. Aquatic Organisms: Utilization of Habitats Exposed to Triallate Usage

Agricultural uses of triallate may border valuable aquatic habitats such as streams, rivers, lakes, and freshwater marshes. The numbers of species potentially effected is large and the types of habitat

exposures quite varied. Table 29 provides a general overview of the types of aquatic life that is expected to be exposed from various uses of triallate.

Table 29. Terrestrial and Aquatic Exposure from Various Uses of Triallate

Crop or Site	Max Usage Acres	Major States for Usage	Terrestrial Species Common to Usage Locations	Aquatic Habitat Types Common to Usage Locations
Winter wheat	283,000	MT, WA	Deer, ground squirrel, marmot, rabbit, porcupine, pheasant, quail, grouse, ducks, geese, sandhill crane, doves, pigeon, various songbirds	streams, ponds, small lakes, bogs, prairie potholes, freshwater marshes
Spring wheat	1,753,000	ND, MT, MN	pheasant, dabbling ducks, pheasant, grouse, quail, deer, other small mammals	Common freshwater species might include darters, daces, chubs, trout crayfish, mussels (streams), numerous crustaceans in potholes , aquatic plants in all habitats with some rare species in bogs and freshwater marshes
Barley	1,000,000	MT, ID, ND, WA	pheasant, hungarian partridge, ducks, geese and other waterfowl, sandhill crane, mourning dove, grouse, quail sp., and various songbird species deer, antelope, elk, cottontail rabbit, marmot, porcupine, ground squirrels	
Peas dry	75,000	ID, WA	pheasant, mourning dove, partridge, ducks, geese, songbirds, quail, elk , deer, rabbit	
Peas green	47,000	WA, OR	same as above	
Conservation Reserve	7,000	ND	Numerous songbird, gamebird, and waterfowl species (prairie potholes), small and large mammal populations	
Summer fallow	175,000	WA, MT	Numerous songbird, gamebird, and waterfowl species (prairie potholes), small and large mammal populations	

D. Characterization of Ecological Effects

1. Ecological Risk to Birds and Mammals

Based on avian oral and dietary toxicity values, acute risk appears to be low for birds foraging on triallate treated soils, small insects or ingesting water from potholes or puddles containing triallate residues. Chronic risk to birds would require residue levels exceeding 200 ppm on food sources. This exposure level is unlikely with incorporated uses. However, exposure to unincorporated granules is

possible with uses which allow delayed incorporation or use on no till surfaces (which presumably also involve no incorporation). Some chronic risk exposure potential is possible with soil probing species which feed heavily on grubs, earthworms or other soil invertebrates and therefore ingest granules along with soil grit. Effects appear to be limited to growth reduction in adult birds. No adverse effects to reproduction were observed in bobwhite quail tested at up to 500 ppm. Mammals are not expected to be adversely effected based on acute oral and reproductive studies conducted in conjunction with human health safety determination. The consumption of exposed granules by small mammals such as a field mouse might pose some hazard, but this consumption would need to be ingestion of all granules within about a 1.5 square foot area. This scenario does not seem likely and would apply only to unincorporated (delayed incorporation) uses of triallate. Small insectivorous mammals could conceivably ingest residues which might pose some hazard, but this exposure level appears marginal. When exposure is reduced with the incorporated use patterns most commonly used for triallate products the risk potential is substantially reduced.

2. Risk to Invertebrates

Acute high risk to invertebrates is not predicted from runoff from incorporated or unincorporated uses of triallate. However, some uses trigger endangered species risk criteria. Chronic risk quotients for invertebrates are potentially exceeded for unincorporated uses near shallow habitats, but there is some uncertainty associated with expected residue levels for such areas as prairie potholes. Tier II modeling of wheat with incorporation to 2 inch depth in a 2 meter deep 1 hectare pond yields EEC levels of 2.3 ppb which is below levels of concern. In addition, actual monitored residues generally do not exceed 1 ppb, though there have been isolated incidences where levels were higher. These modeled and monitored residues are for deeper water bodies (2 m deep pond or large rivers). Thus, shallow water contamination of potholes, marshes or other similar aquatic habitats might more closely approach chronic toxicity thresholds. Applications will presumably be made in areas where prairie potholes, bogs and shallow marshes are not uncommon. Prairie potholes often serve as important feeding areas for overwintering or migrating waterfowl which benefit from high temporal populations of aquatic invertebrates.

3. Risk to Fish

Acute hazard to fish species from triallate use is not expected. Chronic risk levels of 38 ppb are also not exceeded by maximum model estimated exposure levels. High runoff scenarios of 1.5 lb. ai/A rates with no incorporation do not exceed ½ of the LOEC for chronic effects to rainbow trout. Therefore, exposure levels in deeper waters are not expected to prove hazardous to fish. Monitoring data would appear to support this as maximum detected residues in large rivers generally fell below 1 ppb. Risk potential increases if water depth is shallow, thus potentially increasing total residue levels. This might be illustrated by a shallow marsh feeding into the headwaters of a small stream where breeding fish

congregate because of submerged vegetative cover. However, the levels of residues in such shallow habitats remains an uncertainty at this time.

4. Risk to Amphibians

The agency has not reviewed any literature indicating the toxicity of triallate to adult or larval amphibian life. Based on high toxicity to fish, triallate is expected to demonstrate high toxicity to larval and possibly adult amphibians. As acute levels of concern are not exceeded for fish, acute levels for adult amphibians are also unlikely to be exceeded. Chronic hazard from exposure of amphibia during developmental stages is potentially of concern when use patterns display high potential for runoff, such as unincorporated granular use. High exposure scenarios might involve shallow wetland areas or littoral zones where amphibians breed.

5. Risk to Nontarget Plants

Grasses appear to be the most sensitive terrestrial plant group and therefore the most susceptible to hazard from off target drift or runoff of triallate. Ryegrass and oat showed 25% reduction in emergence from exposure to 0.054 and 0.020 lb. ai/A of triallate, respectively. This is equivalent to 1/30 of the maximum application rate. Certainly this might have implications for native grassland areas surrounding application sites. The potential of such exposure is reduced, but not eliminated by the recommended immediate incorporation on most labels. This reduced exposure potential does not apply to less commonly used delayed incorporation or no tillage practices where exposed granules are more susceptible to lateral off site transport.

The same practices that are more likely to expose terrestrial plants to runoff are also the most likely to expose aquatic plant species. In addition, aerial application of the granular with no protective buffers around aquatic habitats is a potential path of exposure for which the Agency has little data. The Agency has received no fully acceptable data to characterize the toxicity of triallate to aquatic plant species. Based on a single study with *Selenastrum capricornutum* triallate displayed high toxicity to a freshwater aquatic algae with an EC50 of 120 ppb. However, modeled maximum exposure projected for the use of triallate place expected EEC levels in 2 meter depths at no more than 15 ppb. More sensitive aquatic plants may be effected at lower levels and exposure levels would be higher at more shallow depths. Therefore, hazard to aquatic plants from triallate use cannot be completely assessed or dismissed at this time.

6. Risk to Non-Target Insects

Based on acute dermal and foliar residue feeding studies with honeybees, beneficial pollinators are not expected to be adversely effected. Aquatic and semi-aquatic larvae of terrestrial insect species are

expected to be sensitive to triallate if exposed in aquatic habitats. However, modeled environmental concentrations would not exceed acute levels if toxicity is assumed similar to that observed for aquatic crustacea (*Daphnia magna)*.

7. Risk from Dual Active Mixture

a. Toxicity of Dual Active Mixture

No actual toxicity data for the BUCKLE formulation containing 10% triallate and 3% trifluralin have been provided. In general trifluralin demonstrates higher toxicity to fish and higher chronic toxicity to birds, fish and possibly aquatic invertebrates. Table 30 compares toxicity values for the same test species exposed to triallate or trifluralin as separate test compounds.

Table 30. Triallate - Trifluralin Toxicity Comparisons

Species Tested	% ai	Triallate	% ai	Trifluralin
Bobwhite quail	95	LD50=2251 mg/Kg	96	LD50>2000 mg/Kg
Bobwhite quail	96	LC50>5620 ppm	99	LC50>5000 ppm
Bobwhite quail-chronic	tech	LOEC=200 ppm	99	LOEC=5 ppm
Rat	tech	LD50=800 mg/Kg		
Honeybee	tech	LD50>25 µg ai/bee	tech	LD50 = 24 µg ai/bee
Waterflea, *Daphnia m.*	95	EC50=91 ppb	95	EC50=560 ppb
Waterflea, *Daphnia m.*	95.5	21D LOEC=13 ppb	97	64 D LOEC=2.4 ppb
Bluegill sunfish	97	LC50=1300 ppb	95	LC50=8.4 ppb
Rainbow trout	97	LC50=1200 ppb	95	LC50= 22 ppb
Rainbow trout chronic	96.8	LOEC=38 ppb		no trout ELS
Fathead minnow chronic		No Fathead ELS	97	LOEC=1.9 ppb
Algae *Isochrysis galbana*	99	48 HrEC50=390 ppb	96	240 Hr EC50=2500 ppb

The toxicity database for trifluralin is substantially more complete and diverse than data for triallate. Nearly complete data are available for trifluralin toxicity to aquatic plants with toxicity ranging from 15 to 339 ppb for freshwater aquatic species.

b. Hazard From Dual Active Mixture

The use of trifluralin and triallate mixed together in BUCKLE granular herbicide formulation, presents some unique problems. Though triallate and trifluralin display similarly low acute and dietary toxicity levels to birds, the chronic LOEC for trifluralin is forty times lower than triallate (5 ppm v.s. 200 ppm) based on numbers of eggs cracked in mallard studies with trifluralin. A slight, but statistically insignificant, ($p<0.05$) increase in cracked eggs was also noted in the bobwhite avian reproduction study. No other effects were noted at up to 50 ppm (the highest dose tested). Thus, addition of trifluralin may increase likelihood of chronic effects to birds if they are sufficiently exposed. Based on the fact that BUCKLE is directed to be ground incorporated on labels, it not predicted that exposure will be sufficient to lead to chronic hazard.

Use of BUCKLE is also not expected to lead to hazardous acute toxicity levels to aquatic invertebrates. However, trifluralin displays higher chronic toxicity to invertebrates than triallate under long term exposure. Trifluralin also is less persistent than triallate. Thus, potentially additional chronic hazard from addition of trifluralin to triallate appears to be reduced by shorter exposure time, with only slightly increased hazard over the levels predicted for 1.5 lb. ai/A applications of triallate alone. Runoff of trifluralin from BUCKLE applications could pose additional hazard**,** though acute toxicity tests results show larval arthropoda (insect larvae) to be less sensitive to trifluralin than crustacea with LC50 levels above 1000 ppb.

Addition of trifluralin to triallate is expected to increase the toxicity of BUCKLE to fish over that of products containing triallate alone. Trifluralin is over 50 times more toxic to rainbow trout and over 150 times more toxic to bluegill sunfish than triallate. Based on a 3% addition of the more toxic trifluralin to the 10% triallate already contained in BUCKLE, a potentially increased level of risk is possible for fish exposed to combined residues from runoff of this mixture.

VIII. ADEQUACY OF TRIALLATE FATE, EXPOSURE, AND TOXICITY DATA

The original fate data (MRID 00144567) were accepted as fulfilling the data requirements, although many appear to be marginal by current standards. It was not recognized at the time that triallate's volatility may have contributed to the difficulties encountered in the earlier studies. EFED recommends that the registrant upgrade the previously submitted fate data (MRID 00144567) in accordance with the current guidelines. Although triallate has no aquatic uses, it is recommended that the registrant submit Subdivision N guideline aerobic and anaerobic aquatic metabolism studies. Aerobic and anaerobic

aquatic half-lives are needed in tier II modeling (PRZM / EXAMS) to better assess the concentration of triallate in surface water.

A significant data deficiency was the inadequacy of the environmental fate data for the metabolite (TCPSA). This metabolite of concern is included in the Health Effects Division's tolerance expression. The submitted fate data for TCPSA were derived from structural activity relationships and from a limited number of preliminary laboratory studies. These data are deemed as supplemental for the purpose of risk assessment. Confirmatory data are needed to substantiate the supplemental data.

Triallate eco toxicity data are not sufficient in certain areas. An adequate battery of aquatic plant tests has not been performed for this chemical. The registrant has attempted to provide some limited aquatic plant data (one species), however this does not fulfill this data requirement. Toxicity of triallate and trifluralin together (BUCKLE granlular herbicide) is also not well understood as no mixture data on toxicity to avian or aquatic organisms has been provided by the registrant for this product. Based on high chronic toxicity of trifluralin to birds and higher chronic and acute toxicity of trifluralin to aquatic organisms the addition of this chemical is expected to heighten toxicity over that of triallate alone to these species groups. Chronic testing of aquatic invertebrates is only partially acceptable as no determination of potential effects to growth can be made. Presently no exposure to estuarine habitats and organisms has been considered due totriallate's exclusive use in the north central region of the United States. Future use petitions involving crops which may expose estuarine organisms should be accompanied by acute and chronic testing of estuarine fish and invertebrates (guidelines 72-3 and 72-4).

REFERENCES

Goos, R. J. and Ahrens, W.H ; Ammonium thiosulfate effect on herbicide longevity in soil. Agronomy Journal. V. 84 (3); 459-463 (1992).

Kenaga, E.E.1973. Factors to be Considered in the Evaluation of the Toxicity of Pesticides to Birds in Their Environment. Environmental Quality and Safety Global Aspects of Chemistry, Toxicology and Technology as Applied to the Environment Vol. II Eds: Coulston, Albany, N.Y.Korte, F. Munich. Georg Thieme Publishers, Stuttgart Academic Press, Inc., New York, N.Y.

Kolpin, D.W., Barbash, J.E., and Gilliom, R.J. Occurrence of Pesticides in Shallow Groundwater of the United States: Initial Results from the National Water-Quality Assessment Program. Environ. Sci. Technol. V. 32: 558-566 (1998).

Majewski, M..S. and Capel, P.D ; Pesticides in the environment: Distribution, Trends, and Governing Factors. U.S. Geological Survey. Open-File Report 94-506. National Water Quality Assessment Program (1995).

Smith, A.E., Kerr, L.A., and Caldwell, B. Volatility of ethalfluralin, trifluralin, and triallate from a field following surface treatments with granular formulations. Journal of Agricultural and Food Chemistry. V. 45 (4): 1473-1478 (1997).

APPENDIX A

NAWQA Surface Water Data for the Red River of the North Basin

Station Number	N	Sample Timing	Annual Peak	TWA Mean Non Modified	TWA Mean Detection Modified	Mean
5030140	2	8/94-8/95	0.0005			
5030150	2	8/93-8/94	0.0005			
5046000	3	5/94-8/95	0.0005			
5049000	1	6/94	0.0005			
5053800	10	4/94-11/94	0.038	0.0036	0.0039	0.005
	10	1/95-9/95	0.038	0.0057	0.0061	0.005
	2	8/96	0.0005			
5051300	2	5/94-7/94	0.005			
	1	8/95	0.0005			
5056000	2	7/93	0.0005			
5058700	1	8/95	0.0005			
5059000	4	6/94-9/96	0.0005			
5062100	2	6/94-7/94	0.006			
5062435	1	6/21	0.008			
5062500	20	3/93-10/93	0.21	0.06018	0.060	0.002
	7	2/94-8/94	0.037	0.00733	0.007	0.013
	7	5/95-10/95	0.006	0.00312	0.003	0.002
	1	10/96	0.005			

5063000	1	6/94	0.027			
5064000	1	6/94	0.038			
5066500	2	5/94-7/94	0.008			
5075300	1	7/95	0.0005			
5076200	1	7/95	0.0005			
5078500	1	7/95	0.0005			
5082625	24	3/93-12/93	0.0160	0.00118	0.0015	0.003
	7	2/94-8/94	0.012	0.00217	0.0025	0.003
	1	6/95	0.0005			
	1	10/95	0.0005			

APPENDIX A

NAWQA Surface Water Data for the Red River of the North Basin

Station Number	N	Sample Timing	Annual Peak	TWA Mean Non-Modified	TWA Mean Detection Modified	Mean
5082650	1	6/94	0.0005			
5083100	1	6/94	0.005			
5085080	1	5/94	0.008			
5085900	24	4/93-12/93	0.28	0.07751	0.0776	0.027
	8	3/94-9/94	0.061	0.02262	0.0226	0.022
5086500	1	6/94	0.013			
5087500	1	8/94	0.0005			
5087600	1	6/94	0.008			
5091000	2	8/93	0.0005			
5095500	2	5/94-8/93	0.005			
5096000	1	8/93	0.0005			
5097500	1	5/94	0.005			
5102490	18	4/93-10/93	0.067	0.021394	0.0215	0.011
	11	1/94-11/94	0.024	0.006373	0.0067	0.010
	7	4/95-10/95	0.053	0.019043	0.0191	0.009

	5	4/96-10/96	0.044	0.018072	0.0183	0.010
5112000	1	7/94	0.0005			
4630000000000	2	8/95	0.0005			
4640000000000	1	8/94	0.0005			
4720000000	1	6/94	0.028			
4760000000	2	6/94	0.004			
4800000000	1	6/94	0.004			
4810000000	1	6/94	0.005			
4820000000	1	8/93	0.008			

APPENDIX A

Triallate Concentrations in the Central Plateau of the Columbia River

Station Number	N	Sample Timing	Annual Peak	TWA Mean Non-Modified	TWA Mean Detection Modified	Mean
12464606	6	2/95-5/94	0.0005			
12464770	14	4/93-12/93	0.013	0.0046	0.0048	0.003
	5	1/94-4/94	0.65	0.0106	0.0117	0.013
	2	1/95	0.53			
12471090	5	4/94-2/95	0.0005			
12471400	5	4/94	0.0005			
	2	1/95-2/95	0.007			
12471485	1	10/94	0.0005			
12471724	4	4/94-5/94	0.0005			
	4	6/95-7/95	0.0005			
12472000	3	5/94	0.0005			
12472380	22	3/93-8/93	0.0005			
	6	1/94-5/94	0.0005			

	8	1/95-7/95	0.004	0.00007	0.0005	0.001
12472400	1	5/94	0.0005			
12472500	1	5/94	0.0005			
12472600	4	4/94-5/94	0.0005			
	2	1/95-2/95	0.0005			
12472950	1	2/96	0.0005			

APPENDIX A

Triallate Concentrations in the Central Plateau of the Columbia River

Station Number	N	Sample Timing	Annual Peak	TWA Mean Non-Modified	TWA Mean Detection Modified	Mean
12473508	4	4/94-5/94	0.0005			
	4	2/95-7/95	0.0005			
	1	2/96	0.0005			
12473740	17	4/93-12/93	0.0005			
	8	1/94-8/94	0.0005			
	1	2/95	0.0005			
12513650	4	4/94-5/94	0.0005			
	1	2/95	0.0005			
	1	2/96	0.0005			
13346000	4	4/94-5/94	0.0410	0.0114	0.0114	0.020

	1	7/95	0.006			
13346990	1	4/94	0.06			
13349200	4	4/94-5/94	0.095	0.0938	0.0938	0.080
	1	7/95	0.007			
13349320	5	4/94-5/94	0.015	0.0119	0.0119	0.012
	1	7/95	0.009			
13349410	5	4/94-6/94	0.027	0.0336	0.0336	0.025
13349900	1	4/94	0.014			
13350500	1	4/94	0.042			
13350700	1	4/94	0.012			
13351000	18	3/93-12/93	0.41	0.03048	0.03054	0.053
	15	1/94-12/94	0.49	0.03019	0.03001	0.058
	11	1/95-11/95	0.33	0.04784	0.0478	0.099
	2	11/96-12/96	0.046			